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ECORailS –
Energy efficiency and environmental criteria in the awarding of regional rail transport vehicles and services

Deliverable 19:
1st draft of the Guidelines

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Title:
Energy efficiency and environmental criteria in the awarding of regional rail transport vehicles and services

Distribution:

Partic N°	Participant name	Participant short name	Country code
CO	TSB Innovation Agency Berlin GmbH FAV – Transport Technology Systems Network	TSB FAV	DE
CB 2	Senate Department for Urban Development	SenStadt	DE
CB 3	Pro Rail Alliance	ApS	DE
CB 4	KCW GmbH	KCW	DE
CB 5	Berlin University of Technology	TUB	DE
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CB 12	CFR Timişoara – National Society of Railway Transport	CFR	RO
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CB 14	Budapest University of Technology and Economics	BME	HU
CB 15	Agenzia della Lombardia Orientale per i Trasporti e la Logistica	ALOT	IT

Content

General comments

- This is the first draft of the Guidelines for using environmental criteria in awarding procedures for regional passenger rail services (= Deliverable 19 of the ECORailS project). It is a first compilation of the results which have already been achieved by the activities of the ECORailS consortium. The structure of the document was elaborated and agreed by the ECORailS consortium and the Editorial Group on several meetings in 2009.
- The aim of publishing this 1st draft is to get feedback from European stakeholders. Comments are welcome by all means of communication and should be directed to Mr. Matthias Pippert, Allianz pro Schiene (see contact data on the first page of the document). Results and comments can be discussed by invited stakeholders on the 2nd "User Platform", scheduled for 18th/19th February 2010 in Berlin.
- The 2nd draft of the Guidelines (Deliverable 20 of the ECORailS project) will be published end of March 2010. For this purpose the present document will be further elaborated, improved and better adapted to the structure agreed upon by the consortium. Further feedback referring to the 2nd draft will be welcome at any time after March 2010.
- For this document substantial input was provided by the Deliverable 9 of WP3 "Legal and economical overview including legal text modules for awarding ready to be integrated into the guidelines" and by the Working Paper 17 of WP2 "Pilot Catalogue of technologies and operational measures". It further bases on the Deliverable 6 of WP2 "Technological overview with regard to energy efficiency and environmental performance, ready to be integrated into the guidelines".
- It is proposed to divide the Guidelines into four main parts as follows:

  I. General considerations

  II. Legal and economical framework

  III. Core part of the guidelines

  IV. Results of the case studies, further background information

  It is not yet decided whether part IV will be an integral part of the Guidelines or only background information to be published on the ECORailS website. This can be decided later on, i.e. 2nd half-year of 2010. All information which will be necessary for the pilot applications will be part of Deliverable 13. Therefore the preparation of a part IV will not be part of the 1st and 2nd draft of the Guidelines (D 19, D 20).
- It was agreed by the Editorial Group that the users need a clear advice which may "lead them through the Guidelines". This can be made by additional chapters, workflow diagrams and respective paragraphs (introductions, conclusions), especially in part I and part III, thus providing a "red line" and give step-by-step proposals for the design of awarding procedures / tender documents. A first attempt is proposed in this version, but it may have to be further elaborated in the editorial process.

- Furthermore, it was agreed by the Editorial Group that ECORailS does not want to introduce a new standard which might compete with the recommendations of the PROSPER project („**P**rocedures for **RO**lling **S**tock **P**rocurement with **E**nvironmental **R**equirements“) which resulted in the UIC Leaflet 345). The main task for ECORailS in this respect is to analyse Leaflet 345, to enable the PTA's to use it, and to give additional comments and information where it seems appropriate. If our analysis shows that the approach of Leaflet 345 is in some respects not appropriate or sufficient for the awarding of regional passenger rail transport, good and manageable recommendations should be given to the PTA's how to deal with these aspects.
- In the same sense it should be clear that we do not want to introduce new standards competing to the results of the Railenergy project concerning the description of the energy consumption of railway rolling stock or the definition of the parameters which are necessary to get comparable results.
- The choice of solutions shown in this preliminary version of the Guidelines has been carried out according to the following criteria:
  - Best energy saving potentials;
  - Large differentiation in terms of potential problems to be faced for implementation (e.g. investment dimension, legal constraints, safety or environmental risks, implementation time, traction systems, etc.);
  - Experience of already awarded technologies and operational measures;
  - Applicability in WP4 pilot case studies;
  - Representativeness across technological clusters and clusters of operational solutions.
- Allianz pro Schiene who is responsible for the editorial process of the Guidelines wishes to thank all partners of the ECORailS consortium for their strong commitment to the objectives of the project, the intense and effective work and the valuable contributions. We would like to apologise that not all comments have been integrated yet appropriately due to time and capacity reasons. This will be caught up as far as possible in the next version.
- The ECORailS consortium wishes to thank all stakeholders who have already been involved in meetings or discussions of our project for their commitment and valuable input.
- We kindly ask all readers to respect that this is a preliminary version and neither Allianz pro Schiene nor any other partner of the ECORailS consortium will accept any liability for problems which may occur by using this version in real awarding projects or other circumstances.
- This document is a draft version with contributions of several partners of the ECORailS consortium. The statements in the document do not necessarily represent the opinion of Allianz pro Schiene of any other individual partner of the consortium.

Paragraphs with yellow background are intended to be eliminated when finalising the Guidelines at the end of the project.

Commented Structure

Part I: General considerations (c. 20 pages)

Chap-ter	Sub-chap-ter	Title, keywords
0		**Introduction** *(short, c1 page)* • Purpose to which the Guidelines were elaborated • Context (IEE – ECORailS – other European projects) • Work methodology (WPs structure and role, the users' co-operation and feedback, User platform, pilot applications , etc.)
1		**Environmental, political and economical relevance of saving energy in passenger rail transport**
2		**General conceptual decisions of PTA which could influence the energy efficiency and other environmental effects of the services to be awarded** (one paragraph: Energy efficiency and passengers' needs)
3		**Discussion: different methods of awarding services by the PTA** *(2-3 pages)* • general description (and definition) of different methods • pros and cons (very general, possibly including a SWOT • general description how environmental criteria could be used in the different methods • Extract / comprehension of chapter 5 in part II *(This chapter will be an extract of part II and should also comprise definitions of wording like "awarding", "tendering" etc.)*
4		**State of the art, present and foreseen trends** *(c5 pages)* *(Including short descriptions and references to PROSPER (UIC Leaflet 345) and Railenergy)*
	4.1	Technology (rolling stock, traction technology etc.) *Including: Main issues of ee technologies can be mentioned and explained (only examples like the 11 technological clusters)*
	4.2	energy-efficient operation *Including: Main issues of ee operation can be mentioned and explained (only examples like the 8 operational clusters)*
	4.3	State of the art in terms of procuring environmentally friendly railway rolling stock *Mainly including: the approach of UIC Leaflet 345 and similar*

		projects
	4.4	Methodology to describe / to define energy consumption in terms of regional passenger transport *Including: why it is so difficult to describe the energy consumption of a train, what is the state-of-the-art* *Including: Target value: The potential is different from region to region. It should be only a description on why target values are important*
	4.5	Inclusion of energy efficiency criteria/requirements in the awarding of regional passenger services or in the procurement of vehicles for this kind of operation *Including: explaining the main ways/solutions to reach ee and eco objectives including target values (and why it is better to describe target values instead of solutions)*
	4.6	Noise emission and pollutants
5		**New rolling stock vs. old /modernised or second-hand**
6		**Rolling stock and infrastructure** (general remarks) • showing the technological potential • showing how PTA's can act on this
7		**Good-practice examples for energy-efficient and environment-friendly regional rail passenger transport**

8		**Further considerations (future development including technological and legal aspects; noise, pollutants, other rail transport segments)** *Including: New vehicle concepts, renewable energy and alternative fuels*
9		**General advices: How to include environmental criteria in an awarding project**

Part II: Legal and economical framework (c. 20 pages)

Chap-ter	Sub-chap-ter	Title, keywords
1		**European law relevant for awarding and tendering** • *Not only 1370/2007* • *what does competitive tendering mean in concreteness for using ee and eco criteria* *WP 3 will propose how to split the explanations of different ways of awarding as well as the pros and cons for the respective methods between Chapters 1 and 4*
2		**National law for awarding and tendering in the participating countries** *Comment: Main approaches of national law in EU member states concerning awarding procedures for regional passenger rail services*
3		**Relevant European and national law concerning energy efficiency and environment**
4		**Consequences for the use of energy-efficiency criteria in the awarding process** **a) Awarding train services (TOC)** **b) Procuring vehicles by the PTA** **Relation to the Infrastructure managers**
5		**Considerations about energy efficiency and different legal frameworks and / or awarding methods** • *Can EE and EF criteria be used in all relevant methods of awarding?* • *To discuss whether certain awarding methods have advantages compared to other awarding methods* • *Finally an assessment is intended (deepening the pro's and cons' see Part I Chapter 4)*
6		**General advices for the use of the guidelines under the legal framework in other than the participating countries**
7		**Considerations for the adjustment of European and national law in terms of energy-efficiency criteria** (Addendum by IRD: Considerations referring to the application or adaptation to the European and national legislation with a view to supporting and developing the railway transport which meets the energetic and environmental criteria, as compared with other means of transport.)

Part III: Core part of the guidelines (c. 40 pages)

Chap-ter	Sub-chap-ter	Title, keywords
0		**Steps for integrating environmental criteria in awarding procedures**
1		**General comments on the use of the criteria described below** *(I.a.: what does "legally secure" mean? General considerations about indicators, equipment, operational measures etc.)*
2		**Application to different types of contracts** • Operation, rolling stock provided by TOC • Operation, rolling stock provided by PTA • Direct Procurement of rolling stock by PTA • Direct procurement of rolling stock by TOC • Procurement of rolling stock via leasing companies • Modernisation paths Comments: • *reference to criteria which can be applied in the methods* • *In general: Introduction for chapter 3-8* • *First 5 bullet points are most important types of contract. Chapter should give a roadmap whether one of these types should be chosen, and in which steps one can include ee/eco criteria* • *Modernisation path is a UK model: the state or leasing companies own old vehicles. TOC's can use it, but have to use a new fleet after a timeframe of some years*
3		**Application to different types of operation** • Diesel operation, loco-hauled / DMU's • Electric operation, loco-hauled / EMU's • Different service profiles (acceleration, speed) *(introduction for chapters 4-10)*

4		**Direct indicators (traction energy consumption)** *E.g.:* • *kWh per passenger km* • *kWh per seat km* • *kWh per train km* • *kWh per gross tonne km* • *potentials and limits of all indicators should be discussed*
5		**Indirect indicators** *(e.g. weight per seat km)*
6		**Features and equipment of the vehicles to be used** *(Third best option)*
	6.1	Energy recovery (electric traction)
	6.2	Energy recovery (diesel traction)
	6.3	Storage of energy on board
	6.4	Storage of energy in fixed installations
	6.5 sqq.	*(further criteria)*
7		**Life Cycle Costs (LCC) and Cost-Benefit-Analysis (CBA)**
8		**Stand-by and comfort functions**
	8.1	Stand-by functions (“parked trains”)
	8.2 sqq.	*further criteria*
9		**Energy-efficient driving and driver training**
10		**Further operational measures**
11		**The use of renewable energy or “alternative” fuels**

Part IV: Results of the case studies, further background information (c. 40 pages)

Chap-ter	Sub-chap-ter	Title, keywords
1		**General concept of the case studies**
2		**Case study Denmark / Sweden**
3		**Case study Germany**
4		**Case study Italy**
5		**Case study Romania**
6		**Conclusions and recommendations** *(based on the case studies)*
7		**Further good-practice examples for energy-efficient regional rail passenger transport**
8		**Further innovations being developed or considered by the railways and the rail supply industry**

The Chapters 1 – 6 correspond with Deliverables D 12 – D 14. These chapters will not be part of the 1st and 2nd draft of the Guidelines, but may be integrated in the final version.

The way of publication still has to be discussed – either integral part of the Guidelines (with translation into other languages) or online in English only. Nevertheless, it was agreed that at least a summary should be an integral part of the Guidelines thus showing that and how we tested and validated the draft Guidelines in our pilot applications.

Part I: General Considerations

0 Introduction

- Purpose to which the Guidelines were elaborated
- Context (IEE – ECORailS – other European projects)
- Work methodology (WPs structure and role, the users' co-operation and feedback, User platform, pilot applications , etc.)

Part I

1. Environmental, political and economical relevance of saving energy in passenger rail transport

(…)

Part I

2. General conceptual decisions of PTA which could influence the energy efficiency and other environmental effects of the services to be awarded

(...)

Part I

3. Different methods of awarding services by the PTA

3.1. General description

In compliance to European law the awarding of public transport services can be provided through *competitive tendering* or through a *direct awarding* procedure.

In a *competitive tendering* procedure the competent authority (PTA) may evaluate a number of interested Train Operating Companies (TOCs) in an *open*, *restricted* or *negotiated* procedure. In the open procedure any operator may submit a tender while in a restricted procedure any operator may request to participate in the tender process, however, only candidates invited by the contracting entity may submit a tender. In a negotiated procedure the contracting entity consults one or more selected TOCs and negotiates the terms of the contract with these companies.

In case of *direct awarding* the PTA may award the transport services to a public service operator without entering a competitive tendering procedure. The use of direct awarding is an optional exception for rail services (other than metro and tram) while for other passenger transport modes this is only allowed under special circumstances. National legislation can still prohibit the use of direct awarding of rail services.

When the railway service has been awarded, a Public Service Contract (PSC) between the responsible authority and the TOC has to be established. The PSC is the legally binding act that confirms the agreement between the two contractors and in which the competent authority requires the public service operator to comply with quality standards and technical specifications. The PSC must be in accordance to national law, but the actual standards and requirements may be stricter, e.g. in terms of environmental effects, than required by national or European legislations. The requirement concerning standards and techniques has also to be included in the tender documents.

The Public Service Contract is to:

- define the *public service obligations*[1] to which the public service operator has to comply;
- establish in advance, in an objective and transparent manner, the parameters on the basis of which the *compensation*[2] if any, is to be calculated, and the

[1] a requirement defined or determined by a competent authority in order to ensure public passenger transport services in the general interest that an operator, if it was considering its own commercial interests, would not assume or would not assume to the same extent or under the same conditions without reward.
[2] any benefit, particularly financial, granted directly or indirectly by a competent authority from public funds during the period of implementation of a public service obligation or in connection with that period.

nature and extent of any exclusive rights granted, in a way that prevents overcompensation;

- determine the arrangements for the *allocation of costs* connected with the provision of services.

3.2. How environmental criteria could be used in the different methods

The inclusion of EE/EF criteria in awarding can, from the PTA point of view, be included either in 1) the Public Service Contract or, 2) in the case of the PTA owning the vehicles, in the procurement of vehicles. How to include EE/EF criteria will therefore depend on the following situation:

1. Awarding of services, rolling stock provided by TOC
2. Awarding of services, rolling stock provided by PTA
3. Awarding of rolling stock by the PTA
4. Awarding of rolling stock by the TOC

To include EE/EF criteria the following “legal tools” are available:

- Requirements – The TOC is required to fulfil the specified criteria.
- Incentive – The TOC can be awarded if they manage to fulfil the criteria but can be granted a benefit, for example economic compensation or extension of contract.
- Penalty (or negative incentive) – The TOC is to provide penalties (reasonable and proportionate) for non-compliance to the criteria included in the contract. In case of subsidies, this can be through deducting from the economic compensation.

In addition, in a competitive tendering procedure EE/EF Criteria can also be used for evaluation of the tenders and be weighted together with price and quality parameters.

3.2.1. Requirements

Requirements are criteria that the TOC or the manufacturer must fulfil in order to be qualified for the contract. Using requirements is the most straightforward way to include EE/EF criteria. The following three cases can be considered:

1. inclusion of requirements for operational measures in the awarding procedures for services
2. inclusion of requirements for vehicles in the awarding procedures of services
3. inclusion of requirements for the vehicles in the procurement procedures of vehicles

The third option represents an important issue because in many countries recently, in order to liberalize the railway market, many regional PTAs purchase the rolling stock of their own.

In this case PTAs could require the implementation of a specific solution as it happened in the past, in some countries, when the railways defined technical specifications about operational measures and rolling stock and industry maintained just manufacturing responsibility.

Today PTAs could just ask the keeping of limits on some parameters (e.g. LCC, weight, energy consumption) leaving to industry the responsibility of finding the appropriate solutions or stimulate the manufacturers to achieve better performances for well defined parameters to be evaluated during the tendering process and to be monitored during the commissioning and the operational phases. Also combinations of these methods can be reasonable.

When the ownership of the vehicles is of the PTA and the TOC operates these vehicles, from a technological point of view, it is also relevant how the maintenance aspects should be integrated in the contracts for services, in particular who performs the general overhaul of vehicles and who pays for this. These aspects could be relevant in particular for diesel engines where a bad maintenance by the TOC could cause more toxic and noise emissions, energy consumption and costs for the general overhaul.

For the awarding procedures of services two approaches have been recorded from the first interviews results

- PTAs are willing to ask requirements for solutions both for vehicles and operational measures in the more general interest of the represented communities;
- PTAs hesitate to ask requirements for vehicles.

When asking for vehicle technologies requirements PTAs have to know well:

- in awarding procedures for vehicles, the capability of the manufacturers to supply the technologies required with appropriate Reliability Availability Maintainability and Safety (RAMS) performances;
- in awarding procedures for services, the capability of TOCs to provide or procure rolling stock which fulfils the technological and RAMS requirements.

Within the interview study several examples of requirements for EE/EF criteria were found. The examples are mostly concerning PTAs or TOCs awarding vehicles. In the cases of awarding of rail services the criteria were at first hand covering noise or exhaust emission levels. These examples are summarised in the tables below.

Technological Clusters	Examples of demanded in awarding or planned to be demanded in the future
Cluster1: Train formation or typology	• Different train configurations could be applied • Specifications about train formation are usually in the contracts and in the call for tenders to meet the demand by giving to the commuters the appropriate number of seats or enough space to stand on board.
Cluster 2: Noise and vibration reduction	• Level of internal and external noise • Limits for external noise
Cluster 3: Optimization of comfort functions	• Level of heat conductivity • Some specifications about comfort functions are usually in the contracts and in the call for tenders to improve the quality of the present regional rail service.
Cluster 4: Use of particular materials or structures for mass reduction	• Axle weight limitations • Mass reduction is required and evaluated in the tender, but there are no specifications about the materials. • It is only required for new rolling stock.
Cluster 5: Improvement of traction equipment efficiency	• Specific energy cost of traction
Cluster 7: Reduction of energy consumptions	• Efficiency of braking energy recovering • One example there the reduction of energy consumption was required and evaluated in the latest call for tender for diesel rolling stock.
Cluster 8: Reduction of exhaust pollutants	• In the last call for tender for diesel rolling stock the standard EU Stage IIIa or better was required.
Cluster 10: Revamping of already existing vehicles	• Some specifications about the revamping of old vehicles are sometimes in the contracts or in the call for tender mainly to improve the comfort for passengers when there is not enough money to buy new rolling stock.
Cluster 11: Unconventionally propelled locomotives or Multiple Units	

Operational measures clusters	Required, or planned to be required in awarding (or anyway implemented)
Cluster 1: Training program to raise awareness of personnel	• Energy efficient driving techniques are covered during the training • The theoretical and practical training is followed by involved staff examination.
Cluster 2: Energetic optimization of timetable	• Periodic scheduling, one of the main pillars of the "Integral Regular Timetable" could be viewed as speed harmonization. • All the lines tendered have cadenced timetables • Informal negotiation during the negotiation phase for
Cluster 3 Speed harmonization	
Cluster 4: Optimization of train operation by control centre	
Cluster 5: Energy meters	• Under study as new way of paying the cost of electricity • In some countries, e.g. Germany, this is already required for new locomotives or if a new TOC wants to use the electrified network.
Cluster 6: Management and organization	• Eco-management is under study as a way to save energy costs, too.
Cluster 7: Passenger information systems	
Cluster 8: Noise reduction	• EU regulations about noise (TSI Noise) emissions must be applied. • The protection from noise is also done when modernizing locomotives.

3.2.2. Incentives

Incentives (bonuses and/or penalties) are rather commonly used today in service contracts and are usually concerning criteria like punctuality, growth in number of passengers etc. Incentives can be used in competitive tendering as well as in a direct awarding procedure and is mainly relevant for awarding of services. The argument for including incentives or penalties is to promote (or prevent) a certain behaviour.

Regarding the ECORailS objective, incentives/penalties could be included in order to promote the TOC to reduce energy consumption, noise emissions, or the emissions of pollutants (the latter if diesel vehicles are used). In the interview study, no examples of incentives or penalties concerning EE/EF criteria were found. One reason for this could be the lack of a commonly accepted indicator. Another could be possible uncertainty of the legal situation. The energy consumption of a train also depends on many factors, not only related to the train performance and its maintenance/efficient state. Some of them are: the plane-altimetrical layout of the specific line, the load due to the real number of passengers on board, the planned acceleration and deceleration phases, the environmental conditions

(mainly for the energy consumption due to the equipment for comfort functions as ventilation, heating and conditioning).

For an incentive/penalty to be legally secured it must be clearly described in all tendering documents as well as in the Public Service Contract. This includes the calculation of the compensation/penalty and the method for monitoring its compliance.

3.2.3. Weight criteria for evaluation of tenders

In competitive tendering procedures when awarding of services or rolling stock, different criteria can be used for the evaluation of the tender. In order to compare the tenders, other criteria besides the price can be used for calculation of the best offer. This can be mandatory or non-mandatory criteria.

In the contracts analyzed in the interviews, the most common criteria besides the price were criteria concerning the quality of the services. For example in Italy (Lombardy) the capacity offered during peak-hour were weighted to 10 %. In the Danish "Öresund" case, the quality criteria were in total valued to 30 % of the offer. One example of including EE/EF in the evaluation process was identified. In this case the evaluation of the tenders for environmental criteria was weighted to 2 %. This included values concerning noise and emission and environmental concept (including information to aims, technical methods, measurable achievements for energy retrieving, environmental management and recycling).

For an evaluation criterion to be legally secured, the calculation method, including score system, needs to be described in the tendering documents.

3.3. Pros and cons for including EE/EF criteria

In general it is possible to include EE/EF criteria in the Public Service Contract regardless the type of the awarding procedure. One difference is that within a competitive procedure EE/EF criteria could also be used for choosing between TOCs through including the criteria as a weight for the evaluation of the tenders.

A competitive tendering procedure should also, at least in theory, lead to a more efficient use of energy also without including this as a requirement. The contract is usually awarded to the contender demanding the least compensation for operating the services. Operational costs are one factor that the competing TOCs have to play with in order to increase their competitiveness and increase the chance to win the tender. However, because of technical reasons, charging systems for energy costs, lack of competition etc. energy costs may sometimes have only minor influence. More competition between the TOCs enables the PTAs to implement more requirements in the awarding procedure. If there was only one potential bidder, this would not be possible in this way. This means at the same time, that any barrier on competition would weaken the PTAs position again.

Within a direct awarding procedure there is also (in general) already a well established relation between the competent authority and TOC. Direct awarding also gives the possibility to establish a regional TOC. This has been done for example in Italy. Within a direct awarding procedure, the PTA and the TOC can also arrange the inclusion of EE/EF criteria during the negotiation process. This may also be possible within a competitive tendering procedure, depending on national legislation, however the options will then be much more limited.

In general, the success of including EE/EF criteria may more depend on the overall market situation, e.g. political, economical and legal strength of the PTA, availability of TOC (and their commitment) and availability and quality of rolling stock than type of awarding procedure.

Part I

4. State of the art, present and foreseen trends

In the first phase of work a checklist has been produced within WP2which comprises 83 solutions (technologies and operational measures) grouped into clusters. This part compiled within WP2 is included in this deliverable as a reference in order to facilitate for the reader.

External sources include results from previous or ongoing European projects like Railenergy and PROSPER. In the UIC project PROSPER ("Procedures for Rolling Stock Procurement with Environmental Requirements") a leaflet was produced in which all relevant aspects for the integration of environmental aspects into the procurement process was addressed. The Leaflet ("Environmental specifications for New Rolling Stock") aimed at:

> *"...contribute to harmonisation of the environmental procurement framework in the rail sector at European, and in the long-term global level. By doing so the process of procurement will become more efficient, enabling railways to procure new rolling stock with a sound environmental performance more cost effectively."*

The work within ECORailS and WP3 differs from the PROSPER project by dealing with environmental specifications and energy efficiency from a Public Transport Authority (PTA) perspective.

4.1. Technology (rolling stock, traction technology etc.)

Cluster 1 - Train formation or typology

This cluster includes all choices affecting on the typology of the train, on different combinations of components (e.g. bogies shared between two units) or, at an extreme case, on the change of the whole traction system. Some choices refer to the particular shape of the car body (e.g. double-decked stock) to increase the seating capacity per train length leading to positive impact on energy efficiency and cost effectiveness by a minor weight per seat. A group of technologies in this cluster are related to different ways to compose a train by employing different kinds of vehicles or levering on the length of the train.

Cluster 3 - Optimization of comfort functions

This cluster includes all technologies concerning a new management of comfort functions oriented to avoid wasting electricity. The term “comfort functions” refers to those elements that are important for on-board people (passengers and personnel) like lighting system or system regulating the inner climate. The idea, on which these technologies are based, is adapting the energy consumptions to the different demand situations and avoiding the heat dispersions through the use of insulating materials.

NB: The definition makes sense because the cluster definition is intended for the analysis of technologies. But this definition is a contradiction to the definition by Railenergy which is more useful for being used in our GL. This has to be solved for D 20.

Cluster 4 - Use of particular materials or structures for mass reduction

This cluster describes the employment of new lighter materials (e.g. aluminium for the car bodies, light interior coach equipment) and structure (e.g. sandwich structure) to reduce the total mass of the vehicle. In some cases the originality of the technologies contained in this cluster is to put certain material on the railway market which is already used in other fields.

Cluster 5 - Improvement of traction equipment efficiency

This cluster represents different attempts at increasing energy efficiency taking action directly on traction systems. Obviously the technologies here mentioned are very different from each other due to the different possible traction typologies. Therefore such solutions give rise to changes on motors or on electricity equipments (e.g. transformers), and on auxiliary traction equipments (e.g. their demand-controlled operation).

Cluster 6 - Use of bio-materials allowing recyclability

(...)

Cluster 7 - Reduction of energy consumption

Cluster 7 contains all the technologies generally aimed at reducing energy consumption. This goal can be achieved by re-using energy or exploiting renewable energy sources. Several ways to store (e.g. by super-capacitors) - on-board or in fixed installation - the recovered energy (e.g. the braking energy) are reported in this cluster but the final employments of the recovered energy are essentially two: traction purpose or auxiliary functions purpose. In this cluster there are also some practices based on consumptions recording to allow well planned changes aimed at exploiting eventual margins of energy consumption reduction.

Cluster 9 - Improvement of auxiliary efficiency

(…)

Cluster 11 - Unconventionally propelled locomotives or Multiple Units

The technologies included in this cluster involve new traction typologies (e.g. hybrid solutions) and exploit new propelling machinery.

4.2. Energy-efficient operation

Cluster 1 - Training program to raise awareness of personnel

In this cluster there are some measures that refer to energy efficient driving by studied driving strategies and eventually by driving advice systems. So these solutions implicate a planned analysis of the characteristics of each line (altimetric and planimetric features, speed limits, distance between stops, …) and of the recovery times in the timetable, the study of existing saving energy margins and then the definition of the most opportune driving strategies. Quite obviously, after this technical analysis, it is necessary to acquaint the drivers with the planned changes, to train them and often to stimulate them to do better.

Cluster 2 - Energetic optimization of timetable

Contains operational measures based on timetable optimization. To do that, it is necessary to consider not only the characteristics (distances, signalling, speed…) of the lines but it is basic also to know what the constraints to satisfy the demand are.

Cluster 3 - Speed harmonization

(…)

Cluster 4 - Optimization of train operation by control centre

Includes solutions relating to centralized control of circulation by optimization software to support complex decision making and give driving recommendations from control centre to trains. At an extreme case, an automated driverless operation through centralized optimization of driving style and traffic flows could be clearly more energy efficient.

Cluster 5 - Energy meters

Presents only one measure which consists in energy measurement by installation of energy meters in railway vehicles and record documentation. This solution provides consumption data for an exact energy billing system and for the assessment of energy saving measures (both technologies and operational measures) and their tuning (e.g. from consumption data it is possible to define changes about driving styles, operational measures in cluster 1).

Cluster 7 - Passenger information systems

This cluster involves also the final users in the energy-saving process by letting them know information about composition of the train approaching the platform. In this way the boarding time is decreasing and the delays are reduced. This is relevant for energy efficiency because delays reduce the potentials for energy efficient driving.

4.3. State of the art in terms of procuring environmentally friendly railway rolling stock

Mainly including: the approach of UIC Leaflet 345 and similar projects

4.4. Methodology to describe / to define energy consumption in terms of regional passenger transport

Including: why it is so difficult to describe the energy consumption of a train, what is the state-of-the-art

Including: Target value: The potential is different from region to region. It should be only a description on why target values are important

4.5. Inclusion of energy efficiency criteria/requirements in the awarding of regional passenger services or in the procurement of vehicles for this kind of operation

Including: explaining the main ways/solutions to reach ee and eco objectives including target values (and why it is better to describe target values instead of solutions)

4.6. Noise emission and pollutants

Technologies:

Cluster 2 - Noise and/or vibration reduction

This cluster contains the techniques aimed at reduced noise emissions. Obviously these technologies concern mainly the components that usually are the principal sources of noise because of the presence of friction, such as braking system and wheels.

Cluster 8 – Reduction of exhaust pollutants

This cluster groups technologies aimed at reducing toxic gas emissions through filters, through optimization within the engine or through new techniques already in use in other sectors.

In some areas, a methodology for environmental specifications already exists, for example regarding exhaust emissions for diesel locomotives and DMUs. However since this is not the case when it comes to energy consumption, another approach is needed. In the PROSPER project the term Performance Specification was used for describing environmental specifications to be quantified by the manufacturer for which no target values are set. The manufacturer is asked to specify a certain performance value to be calculated or measured under defined conditions[3].

Operational measures:

Cluster 8 - Noise reduction

These solutions are mainly noise-reduction oriented. They consist in an evaluation of noise emissions during the awarding process (e.g. noise driven procurement) and/or during the operation time (e.g. Identification of noise and wheel flats by trackside fixed measurement systems in strategic sections of the track).

[3] UIC CODE 345R Environmental specifications for new rolling stock, 2006, 1st edition, pp.21-22

Part I

5. New rolling stock vs. old /modernised or second-hand

(...)

Cluster 10 - Reconditioning/revamping of vehicles that already exist

This cluster comprises some technical adjustments on already existing vehicles. In many cases, the high disposal costs and the elevated costs to acquire new rolling stock could justify changes on old fleets to reduce energy consumptions, noise and emissions. The actions on old trains can be substitutions of motors with more efficient ones (also unconventionally propelled motors), or their upgrading or substitution of other components (e.g. interior coach equipment, compressors …) that actually can be realized with better performances.

(...)

Part I

6. Rolling stock and infrastructure

(General remarks)

- showing the technological potential
- showing how PTA's can act on this

Part I

7. Good practice examples of awarding involving environmental standards

First of all, it has to be acknowledged that currently there are only first approaches for awarding with environmental standards. And with regard to the specific awarding, all of these approaches are only minor in relation to the overall awarding and their criteria. Economic criteria are still the most important criteria for the PTA. Nevertheless there are some good practice examples which are initiations on which further awarding can build on.

7.1. Netz Stadtbahn of Berlin and Brandenburg, Germany

In May 2009 the so-called 'Netz Stadtbahn' in the Capital Region was awarded in a tender to the only two bidders Deutsche Bahn (state-owned) and ODEG (an indirect subsidiary of the federal state-owned Hamburger Hochbahn). The tender was operated by the VBB on behalf of the Federal states Berlin and Brandenburg. Some of the lines were crossing the border to the federal states 'Saxony-Anhalt' and 'Mecklenburg-West Pomerania'. The tender of the overall 16 regional lines was devided into four lots. At the end, Deutsche Bahn and ODEG both won two lots.[4] The contract period is twelve years from 2011 to 2022.

The main awarding criterion was the price. The weighting of this parameter was 70%. The remainder 30% were quality criteria. Environmental criteria were included in these quality criteria – besides rolling stock, timetable features and service elements. The weighting of these environmental criteria was 6% (of the 30% of the quality criteria). Thus the total weighting of the environmental criteria was less than 2%. This shows imposingly its minor influence.

The tender defined environmental criteria as values concerning noise and pollutants as well as an environmental concept (including information on aims, technical measures, measurable achievements e.g. for energy retrieving, environmental management, recycling).

7.2. Regional rail network of Lombardy, Italy

The regional IM of the rail network of Lombardy – Ferrovie Nord – was responsible for the procurement of new rolling stock. The company did so on behalf of the regional government. The rolling stock was manufactured by Stadler. The first vehicles were delivered in 2009.

The aim of the awarding was to order new DMU (diesel multiple units) for the regional passenger transport. Energy-efficiency criteria were also considered in the awarding. This includes a lowered weight (kilo per seat rate) as well as the on-board use of recovered braking-energy. Furthermore the European emission standard ("stage IIIa") for diesel engines was required, but improvements above that standard were not rewarded.

[4] It has to be noted that the rules of the tender were constructed in a way that one bidder could win a maximum of two lots. Since there were only two bidders, this decision was consequentially.

7.3. The Swedish part of Öresundtrafiken, Skånetrafiken

At the Swedish part of the contract for the railway services in the Öresund area the following environmental requirement was included in the contract:

- Demand on renewable energy source
- Routines for recycling of waste disposal
- Vehicle washing
- Staff is to be educated in how to reduce the environmental impact from service operation, onboard services and vehicle maintenance.

For compliance to these environmental demands the TOC has to annually deliver an environmental report. The PTA has the right to monitor the compliance through an external inspector and also has the right to change the environmental demands during the contract period, however the TOC must then be compensated if this means increasing costs. This proceeding is similar in other countries or regions, e.g. in Germany.

7.4. Conclusion

The mentioned examples show that there are positive approaches towards integrating environment-related criteria in tenders of regional rail services or the procurement of new rolling stock. The shortly described examples illustrate the different elements, which can be adopted in future awarding.

Nevertheless, such good practice examples are still rather the exception than the standard procedure. Indeed the necessity and usefulness of environmental measures are generally accepted; nevertheless economic reasons are already the main criterion for decisions concerning the procurement of rolling stock and awarding regional rail services. Thus the potential – even on the economic side – that environmental measures could have (besides positive effects on the environment and the public opinion) has to be explained to the PTA and the TOC.

Part I

8. Further considerations (future development including technological and legal aspects; noise, pollutants, other rail transport segments)

(...)

Including: New vehicle concepts, renewable energy and alternative fuels

Cluster 6 - Management and organization

Solutions in this cluster are legal and administrative solutions. Some of them suggest the way to ask requirements for energy efficiency in the contracts (e.g. LCC driven procurement) as the keeping of limits on some parameters (e.g. LCC, energy consumption, weight…) leaving to the supplier the responsibility of finding the appropriate solutions. These kinds of requirements (e.g. bonus/penalty rules) could also stimulate research and development by suppliers, also in the long term, to achieve better performance for well defined parameters (e.g. LCC, energy consumption, weight…) to be evaluated during the awarding process and to be monitored during the operation time. Other agreements, based on incentive systems, involve driver to stimulate them to save energy.

(...)

Part I

9. General advices: How to include environmental criteria in an awarding project

(...)

Part II: Legal and Economical Framework

1. European law relevant for awarding and tendering

1.1. Primary legislation

Currently the Treaty of Lisbon is the relevant Treaty of the European Community. The Treaty came into force 1st of December 2009.

Basically the principles of the European Treaty have to be observed at awarding procedures. This applies for awarding of regional rail transport as well.
The main principles of the European Treaty are:

- Non-discrimination;
- Proportionality;
- Transparency;
- Equal treatment.

The European procurement directives or the minimum standards for awarding expressed in the regulation (EC) No. 1370/2007 follow these principles. This means that the principles of the European legislation can be used for interpretation or for the closure of regulatory gaps.

1.2. Secondary legislation

1.2.1 European legislation for railways

The goal of the common transport policy is to remove obstacles at the borders between Member States so as to facilitate the free movement of persons and goods. To that end its prime objectives are to complete the internal market for transport, ensure sustainable development, manage funding programs and develop international cooperation. It is also concerned with laying down the conditions under which non-resident carriers may operate transport services within a Member State.

The main focus of European railway policy is the opening of the transport market, interoperability and harmonisation of safety requirements of the national networks and the development of (trans-European) networks.
The instruments of the Commission to realise their objectives are:

- Legislation;
- Compilation and provision of data and knowledge;
- Exchange of ‘best or good practice’-examples;
- Development of guidelines;
- Encouragement of innovations in the field of science and research;
- Harmonisation of standards [e.g. TSI (Technical Specifications of Interoperability)].

Concrete legislative measures are derived from Green- and White Papers, which are summaries of different discussion levels and give basic orientation for the transport sector and which are further substantiated to directives, regulations and decisions.

Essential legislation in the field of railways at present:

- Regulation (EC) No 1370/2007- substantial level of transposition in Member States necessary,
- Directive 2001/14/EC – only basic regulation concerning network access, crucial level of transposition in Member States necessary,
- TSI (Technical Specifications of Interoperability) - several harmonized standards [e.g. Commission Decision 2006/66/EC concerning the technical specification for interoperability relating to the subsystem `rolling stock - noise' of the trans-European conventional rail system – high level of concretization of the regulation.]

Further existing regulations regarding environmental aspects can be found in the COMMISSION STAFF WORKING DOCUMENT *accompanying the* COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL Greening Transport {COM(2008) 433 final}). With this Communication the Commission emphasises the protection of the environment in the transportation sector.

As a general rule for the policy area of transport, the particular negotiation process of the organs of the Community (i.e. especially the Commission, which intends to protect and develop the Common Market and the individual policies for further integration, whereas the Member States intend to protect their right of subsidiarity) is crucial to the assessment of the influence of the Community, universal statements are not possible in the end.

1.2.2 Relevant legal framework for the award of transportation services (regional rail transport)

The relevant legal framework for the award of transportation services in regional rail passenger transport – i.e. basically “how” to award – in the EC found expression in

- the European secondary legislation regarding the financing and awarding of public passenger transport services by rail and by road (Regulation (EC) No 1370/2007),
- the European secondary legislation regarding public procurement (Directive 2004/17/EC – Utilities Directive and Directive 2004/18/EC - Services Directive = European procurement directives),
- the European primary legislation, here, the basic principles of the Treaty establishing the European Community (EEC),
- national (regional and/or local, if any) provisions regarding the awarding of public transportation services, especially resulting from transposition or concretization of European secondary legislation,
- existing jurisdiction, primarily of the European Court of Justice (ECJ),
- the interpretation of European Community Law by the Commission Interpretative Communication on the Community law applicable to contract awards not or not fully subject to the provisions of the Public Procurement Directives (2006/C 179/02).

The succeeding explanations focus solely on European legislation. Transpositions in national law and concretizations remain out of consideration.

Regulation on public passenger transport services by rail and by road (Regulation (EC) No 1370/2007)

The „Regulation of the European Parliament and of the Council on public passenger transport services by rail and by road" has its legal basis in the guidelines of the Treaty establishing the European Community (EEC) regarding the common transport policy (Art. 91 EEC-Treaty) and the common competition policy (Art. 109 EEC-Treaty) and replaces the predecessor rules Regulation No (EEC) 1191/1969 and Regulation (EEC) No 1107/1970. The regulation intends to raise the efficiency and attractiveness of public regional passenger transport. For the first time, the regulation includes provisions which regulate the allowable financing and the awarding of public services in the sector of passenger land transport in the European Union on an area-wide basis. The directive comes into force on 03.12.2009.

Considering the awarding of services in regional rail transport the regulation rules in Art. 5 par. 1 that the procedure has to be executed according to the guidelines of the regulation. However, the depth of control is quite small. Art. 5 par. 3 specifies merely that:

> *"The procedure adopted for competitive tendering shall be open to all operators, shall be fair and shall observe the principles of transparency and non-discrimination."*

As long as the provisions of the European procurement directives (see No. 2) are applied in awarding procedures, the provisions are observed automatically. On the other hand, the wide guidelines of the regulation offer a far greater scope for the Public Transport Authorities (PTA) considering the design of the awarding procedure compared to the stricter European procurement directives. At the same time PTAs are able to procure transportation services in regional rail passenger transport by direct awarding as long as national legislation does not forbid. In this case the maximum contract period is reduced from 15 to 10 years. A prolongation up to 50% with regard to longer amortisation periods is possible.

Generally, the regulation applies to the Member States directly without legislative transposition. However, a large room to manoeuvre remains. Those wide scopes, e.g. regarding the awarding procedures or possible restrictions of direct awarding through national legislation, are a manifestation of the general principle of subsidiarity according to Art 5 EEC-Treaty. This article rules that the European Community takes action only in those areas (also by legislative means) if and as far as it is not possible to the achieve aims of the considered measures by the Member States themselves.

Considering the subject of the service contracts in regional rail transport to be awarded (the „what") the regulation contains only compulsory statements on how the contract has to be specified regarding financing especially to avoid overcompensation. The regulation allows in Art. 4 par. 6 explicitly the inclusion of environmental criteria into the contract:

> *"Where competent authorities, in accordance with national law, require public service operators to comply with certain quality standards, these standards shall be included in the tender documents and in the public service contracts."*

European procurement directives (Directive 2004/17/EC – Utilities Directive and Directive 2004/18/EC - Services Directive = European procurement directives)

Objective of the European procurement directives is to guarantee a transparent and non-discriminatory public procurement ensuring of the fundamental freedom of the Community on the basis of a common competition policy and the regulations of the Single Market (Art. 53, 62 und 114 EEC-Treaty). Contrary to Regulation (EC) Nr. 1370/2007 the awarding procedure

is regulated in great detail. However, attention should be paid to the fact that the European awarding procedures apply only for contracts in the sense of those directives. Unlike with the Regulation (EC) No 1370/2007, the awarding of concessions is not included. A concession guarantees a right, for instance of an operator of a public service, to offer a specified service for a specified period of time to customers. The concessionaire also bears the economic risk of the customer relations, e.g. by generating revenues through compensation for services rendered. Generally, the concessionaire receives no payments for the provision of services from the licenser, the public administration.

The following aspects are relevant for the awarding of regional rail passenger transport:

- For the most part, application of the directives is not compulsory: According to category 18, rail services are non-priority services (Art. 21),
- The Regulation (EC) No 1370/2007 governs the awarding of public service contracts (including concessions) in regional rail transport starting 03.12.2009.

As far as the guidelines of the European procurement directives serve as a rule for awarding procedures, also the (far less strict) specifications of the Regulation (EC) No 1370/2007 are met (see above in section 1). Opposite to Regulation (EC) No 1370/2007 transposition of the European procurement directives into national law in the sense of a standardization of national legislation has to be achieved in 2006.

There are no statements with regard to the subject of the service to be awarded. On the other hand, the directives basically allow freedom of manoeuvre for the contracting authority to specify the subject of the award, e.g. considering energy-efficiency or pollution. In general, the requirements have to be non-discriminatory. For example, the specification of a particular pollution filter (in the sense of a specific producer) would not be allowed. However, the specification of a maximum level of pollution or cleaning method would be permitted, even if these limits were stricter than required by European or national regulations of emission limits.

The establishment of specific environmental evaluation criteria for the appraisal of the offers is possible. The procurement directives define that the environmental standards

- can be associated with the subject of the contract,
- do not admit unlimited scope of action for the public authority,
- have to be mentioned explicitly in the contract notice and the tender documents,
- have to be consistent with the basic principles of EU-legislation.

At an earlier stage of bid assessment it is also feasible to assess the reliability of the bidder and, if necessary, to exclude bidders, e.g. because of registered violation against environmental law or the lack of expertise with regard to the implementation of environment management systems (EMAS[5]).

Recital 5 of Directive 2004/18/EC shows the prominent position of environmental aspects in the directive:

> *"This Directive therefore clarifies how the contracting authorities may contribute to the protection of the environment and the promotion of sustainable*

[5] Regulation (EC) No 761/2001 of the European Parliament and of the Council of 19 March 2001 allowing voluntary participation by organisations in a Community eco-management and audit scheme (EMAS).

development, whilst ensuring the possibility of obtaining the best value for money for their contracts."

Recital 29 describes the freedom of the public authority with regard to the subject of the contract (the „how"):

"Contracting authorities that wish to define environmental requirements for the technical specifications of a given contract may lay down the environmental characteristics, such as a given production method, and/or specific environmental effects of product groups or services. They can use, but are not obliged to use appropriate specifications that are defined in eco-labels, such as the European Eco-label, (multi-)national eco-labels or any other eco-label providing the requirements for the label are drawn up and adopted on the basis of scientific information using a procedure in which stakeholders, such as government bodies, consumers, manufacturers, distributors and environmental organisations can participate, and providing the label is accessible and available to all interested parties. Contracting authorities should, whenever possible, lay down technical specifications so as to take into account accessibility criteria for people with disabilities or design for all users."

Finally, Art. 27 par. 1 of the Directive RL 2004/18/EC specifies further responsibilities with regard to environmental aspects:

"A contracting authority may state in the contract documents, or be obliged by a Member State so to state, the body or bodies from which a candidate or tenderer may obtain the appropriate information on the obligations relating to taxes, to environmental protection, to the employment protection provisions and to the working conditions which are in force in the Member State, region or locality in which the works are to be carried out or services are to be provided and which shall be applicable to the works carried out on site or to the services provided during the performance of the contract."

The European lawmaker underlines by the guidelines mentioned above the high relevance of environmental protection for the Community. The guidelines express the obligation to incorporate environmental aspects in the definition and execution of common policy and measures (especially to promote sustainable development) stated in Art. 11 EEC-Treaty.

Jurisdiction for interpretation of Common Law

Especially the European Court of Justice (ECJ) emphasised the permissibility of environmental assessment criteria in awarding, as long as they are non-discriminatory and they are associated with the subject of the contract (see ECJ on the legal matter C-513/99 - *Concordia Bus* and ECJ on the legal matter C-448/01 – *Wienstrom*). The jurisdiction of EJC leads to the guidelines of the European procurement directives as described above.

1.2.3 Summary – European legal framework

In the range of awarding services through the public authorities the legislative enactment of the EC Treaty describes "how" to get the award rather than the "what". Although it is possible for the Community to ban or to regulate certain products, methods etc., the awarding authority on site can make its own decision within these parameters. Thus, as long as vehicles with certain emissions or specific technologies are not prohibited, the awarding authority is able and allowed to provide services using vehicles that incorporate these

technologies. Furthermore the Community is not restricted to implement incentives for TOCs within the common law.

Part II

2. National law for awarding and tendering in the participating countries and legislation for energy efficiency

In the participating countries there are no prohibitions regarding the use of a certain procedure of awarding for regional railway services. In Italy there has been a governmental decision that by the end of 2007 all regional rail transport has to be awarded by tender. However, partly because of some bad experiences very few competitive tenders have in reality been conducted. Therefore the legislation will now leave it to the regions to decide which awarding procedure to use. In Romania and Hungary the organisation of railway services is very much a centralised process and nearly all railway services are conducted by the national owned railway company which is awarded directly. Also in Sweden and Denmark, part of the regional railway services is operated by the national railway company. However in Sweden, the counties are responsible for awarding of the railway services within the respective county borders and some regional PTAs also cooperate with cross county border traffic systems. In Denmark, about 27 % of the railway services are today awarded through competitive tendering organised by the national PTA Trafikstyrelsen, while the remaining services are directly awarded by the government to the national operator DSB. In Germany regional rail service is awarded by regional PTAs through competitive tendering although direct awarding also occurs.

Results from the interviews conducted with PTAs indicate that the national legal framework regarding awarding is adapting to the European legal framework. Although, since the 1370/2007 EU regulation can be said to have a rather flexible approach where the general legal regulation is to be decided on a national level, it could also be said that for rail services the European legal framework is adapting to the needs of the national and regional level. This means that it will be decided by the member states or even the regions if the awarding is to be done through competitive tendering or through direct awarding.

Based on the interviews, longer contracts between the PTA and TOC can also be expected in the future. Longer contracts can facilitate investment in the rolling stock, since technologies/measures that give lower operation costs, but higher investment costs, will be more profitable. This development also complies with the 1370 regulation which, although stating that contracts should be of limited extension (up to 15 years or 10 years depending on awarding procedure), opens up for using even longer contracts, if a public service operator makes high cost investments in infrastructure or in rolling stock and vehicles.

It is also obvious that in several countries, a process has been initialized in order to strengthening the regional perspective. In some countries, for example Germany and Italy, there are already strong regional authorities present and have a legislative role. They can apply regional regulations in compliance with the national legal framework. Therefore, not only national and European regulations need to be taken into consideration but also a

regional level. Even though stronger regional authorities could make it easier to take the specific regional characteristics into consideration, there is also a risk that the regional level can be an administrative barrier. Especially when the functional regions do not match the administrative borders.

Regarding energy efficiency legislation and policy on the national level there is no legislation directly concerning railway transport in the participating countries. General environmental strategies also concern the transport sector as a whole and not the railway sector specifically. There are examples of some countries which have funding programs for rolling stock in order to modernize the fleet. In Sweden there is a policy (but not legislation) that all energy for electric traction should come from renewable energy source.

A summary of the current national legislation for awarding and policies regarding EE/EF criteria is given in the tables below. This is followed by a description of the legal situation regarding awarding of services and examples of implemented contract.

Additional summarizing information about the national legislation can be found in the country reports of the Deliverable D 9 (chapter 4.3.1), available on the ECORailS website www.ecorails.eu. This information could be included in the Guidelines if the feedback shows that this is appreciated by the users.

Country	Legal framework for awarding of services
Denmark	• Majority of the services is awarded through direct awarding between government and state owned TOC DSB. • About 27 % of the services is awarded through competitive tendering by national PTA Trafikstyrelsen.
Germany	• Regional PTAs responsible for awarding of services. • Increasing number of competitive tenders, but currently most of the service contracts awarded directly.
Hungary	• All services except for the Budapest area is awarded through direct awarding between govnerment and state owned TOC MAV. • Competitive tendering not used (but legally possible).
Italy	• Regional authorities responsible for choosing awarding procedure. • Direct awarding most common but competitive tendering also occurs.
Romania	• CFR-SA functioning as PTA and TOC (Internal operator) under contract with the Ministry of Transport and Infrastructure (under the name CFR Calatori and its 8 regional branches). • For parts of the network that are considered non-interoperable, private companies participate in auction tenders.
Sweden	• State owned TOC SJ has exclusive rights to operate profitable interregional services. • Regional PTAs award rail services within county borders, usually through competitive tendering however direct awarding also occurs. • Non-profitable interregional services are awarded through competitive tenders by the national authority Rikstrafiken.

Table 1 Summary of current legal framework for awarding of services in the participating countries

Country	Examples of legal use or policy regarding EE/EF criteria in regional rail services
Denmark	• No energy- or environment-related legislation/policies regarding rail transport – except for noise. • Diesel engine emissions have to some extent been covered in some invitations to tender. • General (transport) climate strategy includes further electrification of the railway network and energy efficient driving.
Germany	• No legal requirements or minimum standards regarding environmental regulation on national level. • No energy consumption regulations. • "Non-existing" specified environmental strategies regarding railway transport, only abstract targets stating that "railways should be more environmentally friendly"
Hungary	• General environmental regulations for TOCs are defined in the National Railway Regulation and include emission levels for pollutants of diesel traction and noise. • No further environmental requirements/recommendations are included in the contract with the TOC MAV.
Italy	• No national or regional regulations/policies to improve energy savings. • Grants assigned to regions and PTAs aiming at introducing more environmentally friendly DMUs and diesel locomotives. • TOC has to comply with legal rules according to the community law and general environmental regulations. • National regulations for noise emissions of railway vehicles.
Romania	• Modernization program of rolling stock, financed by EU funds (88,51%), state budget (6,5%) and CFR Călători (5%). • Contract between ministry and CFR Călători includes the acquisition program for new rolling stock (multiple electric units, new locomotives and passenger cars). • Real time monitoring of fuel consumption for diesel engines (ICL) used as basis for calculation of the tariff rate for fuel prices. • CFR Călători's modernization and development strategy is to be in accordance with the European legislation.
Sweden	• Policy from the main IM that only renewable energy source to be used for electric traction. • Environmental criteria explicitly allowed to be used by national law but must be clearly specified. • National goal to increase energy efficiency by 20 % to 2020.

Table 2 Summary of current legal use or policies regarding EE/EF criteria in the participating countries

Part II

3. Relevant European and national law concerning energy efficiency and environment

3.1 European legislation in the areas environment and energy-efficiency

As illustrated above, Community Law contains different requirements on "how" to award. The subject of the awarding is left to the discretion of the contracting authority. The contracting authority has to define, describe and procure the services needed. In principle, the Community does not regulate by law the subject of the provisions. This is prohibited explicitly by the EEC-Treaty and would violate the basic principle of subsidiarity.

It is possible, though, that the Community develops and discusses their own positions and applies pressure and influences social debates by their actions respectively. This becomes apparent in the above mentioned possibilities of the Member States to focus on environmental aspects in their procurement activities, for instance the environmental guidelines with regard to awarding procedures.

Eventually, the Community has a broad field of activity concerning environmental and railway policy. This is mostly done by the Commission.

The Community pursuits the following goals with regard to the common environmental policy according to Art. 191 par. 1 EEC-Treaty:

- The conservation and protection of the environment and the improvement of its policy;
- The protection of human health;
- The sustainable and rational use of natural resources;
- The promotion of measures to solve environmental problems on a regional or international level.

The environmental policy of the Community is targeted according to Art. 191 par. 2 subsection 1 page 1 EEC-Treaty on a high level of protection, considering the different circumstances of the individual regions of the Community, i.e. their productivity as well.
The environmental policy is based on three guiding principles (Art. 191 par. 2 subsection 1 page 2 EEC-Treaty):

- Precautionary Principle;
- Abatement of environmental impairments prior at their source;
- Polluter-Pays-Principle.

To achieve their goals, the Community applies Environmental Action Programs which determine the basic targets of the common environmental policy, taking into account the guiding principles. Different legislative measures, i.e. directives and regulations (currently 668) result from those Environmental Action Programs

Examples:

- Directive 2004/26 on the approximation of the laws of the Member States relating to
- measures against the emission of gaseous and particulate pollutants from internal combustion engines to be installed in non-road mobile machinery,

- Directive 2002/49/EC relating to the assessment and management of environmental noise
- Directive 2008/50/EC on ambient air quality and cleaner air for Europe;
- Directive 2003/4/EC on public access to environmental information;
- Regulation (EC) No 761/2001 allowing voluntary participation by organisations in a Community eco-management and audit scheme (EMAS II);
- Directive 2005/32/EC establishing a framework for the setting of ecodesign requirements for energy-using products (Ecodesign-Directive – the directive does explicitly not apply to means of transport for persons or goods, Art. 1 par. 3).

However, the Member States play usually a crucial part in the implementation of the guidelines of the Community, regardless of the character of the guidelines as regulation or directive. The Member States are responsible for the financing and implementation of the environmental policy according to Art. 192 par. 4 EEC-Treaty. The virtual influence of the Community becomes apparent: To implement the common goals of environmental policy the Commission can and may take up topics legislatively, notably if a disparity in law-making threatens to thwart those goals or leads to a distortion of competition. Occasionally, the framework established by this legislation can be very detailed. The Member States are responsible for the further transposition, financing and monitoring according to the subsidiarity principle. In particular cases, legislation by the Community has immediate effects on the EU-citizens, e.g. the so-called lightbulb ban[6]. It is not possible to tell abstractly, when exactly legislative actions of the Community show indirect or direct consequences to the EU-citizens. Rather, it is the result of a negotiation process where the organs of the Community, especially the Commission, intend to protect and develop the Common Market and the individual policies for further integration, whereas the Member States intend to protect their right of subsidiarity. Attention has to be paid to the fact that „energy-effiency" is not an independent policy field of the EC but rather part of the common environmental policy of the Community.

Additional (indirect) instruments of the Commission (in order to apply political pressure) in the area of environment and railways are for example:

- Compilation and provision of data;
- Compilation and dissemination of knowledge;
- Exchange of „best-practice" examples;
- Development of guidelines (see „Buying Green! - Handbook on green public procurement" or the European Commission Green Public Procurement (GPP) Training Toolkit for example);
- Support of innovative activities in the area of science and research;
- Easing of harmonisation of standards;
- Easing of the promotion of projects by the Member States or individual promotion respectively.

[6] Regulation (EC) No 244/2009 with regard to ecodesign requirements for non-directional household lamps (as a consequence of the Ecodesign-Directive).

Part II

4. Consequences for the use of energy-efficiency criteria in the awarding process

4.1 Legal, administrative and market consequences

In general, based on the preliminary results from WP2, the interviews and analysis of European and national legislation there do not seem to be any barriers for PTAs to include energy efficiency and environmental criteria when awarding rail services or rolling stock. At least in the participating countries no changes in current legislation are needed. However, measures could be necessary in some of the countries in order to facilitate this process. Increased use of competitive tendering is mentioned as well as a stronger harmonisation of national legislation with European law. It was also expressed that there is a need for enhanced requirements and establishing of standards regarding noise, emission levels and energy use which also should be possible to change incrementally according to technological progress. For rolling stock the contract authority is basically free to determine the requested scope of performance through its procurement autonomy. The awarding party determines the decisive criteria for the evaluation of the tender but the awarding process must be in compliance with the central principles. The use of environmental issues in the awarding procedures is according to new "Utilies Directive" (2004/17/EC) permissible and desired.[7]

Even though legally possible to include such criteria in awarding there are just a few cases found, where this has been done. Main priorities still concern passenger requirements or load factor optimisation. The situation is rather different when the TOC procures new vehicles. In this case, energy efficiency requirements for rolling stock is standard although not necessarily basis of the decision to purchase a given vehicle or not[8].

Examples of identified legal, administrative and market barriers for implementing EE/EF criteria include:

- Risk of complicated tendering procedures and appealing processes
- Economic situation, awareness of increased investment costs
- Limited or lack of economic incentive for TOC
- Charging system for energy prices
- Limited competition
- Quality of rolling stock and/or infrastructure
- Insulated market for vehicles
- Administrative system

[7] PROSPER II – Draft 3b (final) of UIC Leaflet Environmental Specifications for New Rolling Stock, UIC July 20th 2005
[8] Railenergy, SP1 Results report – WP1.1, 1.2, 1.3 Final report, Draft version

4.2 Risk of complicated tendering procedures and appealing processes

For the PTA the tendering process can be a rather costly and time consuming procedure. It may also be quite common to be confronted with appealing processes, especially if other criteria than the price are involved in the evaluation process. Thus, there can be a risk that PTAs will be hesitant to further complicate the awarding process. Hence EE/EF should be as transparent as possible leaving minimal room for misinterpretation. Demands used as requirements can also be preferable, especially among inexperienced PTAs if it comes to awarding through a competitive procedure.

4.3 Economic situation, awareness of increased investment costs

As mentioned above, the legal situation doesn't seem to be a main barrier for including EE/EF criteria in awarding of services or rolling stock. Maybe the most important reason for the limited use of EE/EF criteria for awarding services are economic issues. Regional rail services are mainly public financed, through subsidies or contract-based, and usually not operated on a commercial basis. This means that public funds are needed, either directly or indirectly, for financing the investment to apply to environmental demands. Therefore, it is important to show the economical effects for the PTA which maybe caused by including EE/EF criteria in the contract. One approach for doing this is using a life cycle cost (LCC) approach. LCC covers the total cost for a product during its period of use, hence covering not only the investment cost but also the operating and maintenance costs. Other parameters can include taxes, subsidies and rest value. Even though a product has high initial costs, low operating and maintenance costs can imply that the product during the contract period can be profitable. This effect can be further enhanced if the operating costs, for example the energy or fuel prices are expected to increase. For a product with high investment costs, the expected period of use is therefore of importance. Contract periods can be one instrument to overcome high initial costs[9]. The European regulation 1370/2007 opens up for contract periods up to 15 years and even longer periods if a public service operator makes high cost investments in infrastructure or in rolling stock and vehicles (as long as the awarding has been done in a fair competitive tendering process).

4.4 Limited or lack of economic incentive for TOC

There can be also a risk of limited economic incentive for TOC to decrease the operational costs. For example, in the case of direct awarding, the compensation can be calculated through the differences between operational cost and the incomes from the services. Therefore if the TOC lowers its operational cost, for example through a more energy efficient driving, the compensation may be reduced by the same amount[10]. This could mean that even though the TOC in the contract is bound to educate its drivers in energy efficient driving, there is a risk that, without an economic incentive, the commitment will be limited. This can be solved by introducing an incentive system by which the TOC is rewarded if the energy/fuel use is reduced. However this also needs a monitoring and reporting system, which, in case of electric traction, requires that the vehicles are equipped with energy meters.

[9] Buchanan and Partners, Guide to Contracts and Contracting in Public Transport

[10] For example, if the operational costs within a contract are estimated to 1 million € and the fare income to 0,6 million €, the compensation paid to the TOC should be 0,4 million €. The introduction of energy efficient driving is supposed to be able to give a reduction of the operational costs by 0,1 million €. This could then mean that the compensation to the TOC would decrease to 0,3 instead of 0,4 million €.

4.5 Charging system for energy prices

Another market barrier is the charging for energy use. Energy prices are in some countries included in the overall track access charge and not charged separately. In some countries, the TOC does not bear the real costs for the electric traction, since the energy prices for the railway network are subsidized. Additionally, existing charges are often not based on actual energy use and therefore independent of the type of train. All these factors can have the effect that reduction of operational costs through use of less energy will be of less importance. These problems are harder to solve through contracting measures. For the PTA, one way to overcome this problem could be to include an incentive system with higher compensation levels for the reduction of energy use. However, this can be rather costly. Instead a national policy change could be necessary which would involve infrastructure managers and the responsible government.

4.6 Lack of competition

One potential market risk is that, when the awarding process is done through competitive tender, there may be only a few contenders taking part in the tender process. As identified in the previous chapter, in all countries there is one major TOC. And this is in any case the state-owned TOC. Even in the apparently liberalised rail market in Germany the incumbent has an outstanding market share. This situation is not expected to change within the next years.

Even though lack of competition is a problem that origins from other reasons than introducing environmental criteria, there can be a risk that including environmental criteria in the process could be a barrier for newcomers or minor TOCs to enter the market, hence further reducing the number of contenders. Reasons for this can be that the tender process can become more complicated and lead to increased commercial risks for the TOC. The latter can especially be the case if the rolling stock is to be provided by the TOC. A small number of contenders can reduce the impact of including EE/EF criteria, especially if using only non-mandatory criteria for the evaluation of tenders. It is therefore important to present necessary information regarding the baseline in order to facilitate for non incumbent operators to take part in the tender.

4.7 Quality of infrastructure and rolling stock

Also the quality of rolling stock and infrastructure can be a barrier. This can influence the use of EE/EF criteria from several perspectives. For example that a modernisation process is seen as more important for the environmental impact than specified EE/EF criteria since modernisation can be considered necessary in order to increase the modal split for railways. In several of the studied countries there is an ongoing modernization process of the rolling stock and infrastructure. This is, of course, a much needed development. A possibility could be that if the purchasing of rolling stock that is done through EU-funding or other national or international funding programs or through lending, EE/EF criteria should be included in these projects. Low quality regarding infrastructure can itself be a barrier through making it hard to use a certain type of rolling stock, technological solutions or operational measures.

4.8 Insulated market for vehicles

Another market barrier could be that an insulated vehicle market can make it difficult or expensive (because of limited market potential) to introduce new technologies. This can be due to special technical standards. For example, in Italy, the use of DC electric power was a

barrier before overtaken by the use of interoperable tilting trains and locos. In Denmark, a special safety system is mentioned as a risk for a somewhat insulate market. Also in Germany, special technical regulations are mentioned as a risk for an insulated vehicle market.

4.9 Administrative system

From a political point of view, in some countries the lack of competent regional authorities is mentioned as a barrier. At the same time, there is the opposite situation in other countries where the regional administrative borders are considered to be a barrier because of too many (and small) PTAs. Even though this is not in itself a barrier for introducing EE/EF criteria, it can in the latter case result that investment costs can be hard to bear. While in the former case it can be hard to adapt the vehicle fleet according to special regional circumstances.

4.10 Consequences related to technological issues

Within WP2 it has been observed that at least 43% of the technologies refer to technical solutions already available in the market and/or already used. Technologies concerning unconventionally propelled vehicles (cluster 11) represent an exception where the majority of them are still under testing. However, most of these technologies are not believed to have any influence in regional or suburban transport.

The technologies requiring additional on board equipments belong mainly to cluster 5 (improvement of traction equipment efficiency), cluster 7 (reduction of energy consumption) and cluster 8 (reduction of exhaust pollutants).

Onboard equipments can be represented by additional motors or generators, by special computers working with particular software suitable for the specific functions or by instruments for noise matters (to reduce noise emissions or to measure them). The majority of the operational measures or the technologies aimed at energy efficiency may obviously require on board energy-meters. Some technologies need both on board equipments and fixed installations (e.g. recovering of regenerative braking energy) and could therefore also need the involvement of the Infrastructure Manager.

The reduction of unnecessary energy losses from auxiliary equipments like ventilation for equipment and passengers, air conditioning and heating systems, parked trains functionalities by an on demand control and timer-controlled strategy seems free of constraints and involving low investment costs.

A relation between the presence of safety, legal and economic risks, or constraints, and the technology's development status has been recorded: the solutions with safety risks and legal constraints are often under testing or R&D technologies. For these solutions, although very promising, safety and legal problems are probably not yet worked out and need a certain amount of work to be done, e.g. towards reaching the consensus of the infrastructure managers.

Environmental risks are mainly related to recycling matters of new materials involved.

For the modernization of vehicles that already exist high costs for specific adaptation of some technologies could be necessary due to the large variety of existing rolling stock.

Technologies like train formation or typology have more impact on the market liberalisation than the management or "soft technical" measures (e.g. optimizing and improving existing services).

The considered operational measures have fewer constraints about their applicability, because they don't depend on the particular kind of traction, but in some cases on the availability of such technologies from the Infrastructure Manager (e.g. signalling and dispatching systems) for the optimization of train operation by a control centre.

Bottlenecks of network, speed restrictions and intense capacity demand of freight operators restrict the effectiveness of some operational measures in regional passenger transport and the PTAs have to stimulate also the Infrastructure Manager to reach better performance and take into account these aspects within the evaluation of operational measures in order to evaluate the opportunity of applying them.

The majority of the presented operational measures is already available in the market and bears no risks for rail access liberalisation. The noise and pollutant emissions seem to be less relevant for ECORailS objectives, because a methodological approach to treat and assess these aspects already exists (some TOC are obliged to meet Stage IIIa exhaust requirements for new engines) and is provided by well defined standards.

4.11 Rail access liberalisation

In this analysis BME has investigated all the proposed 83 measures and the relating clusters whether they risk or promote the ongoing rail access liberalisation process. The most relevant clusters and measures have been selected by the expected implementation time and by their importance. The chance for implementing these measures are the highest, therefore, only these ones have been investigated deeply. The following list shows the most relevant clusters:

- Technology – Cluster 3: Optimisation of comfort functions
- Technology – Cluster 5: Improvement of traction equipment efficiency
- Technology – Cluster 7: Reduction of energy consumption
- Technology – Cluster 10: Reconditioning/revamping of vehicles that already exist
- Operational – Cluster 1: Training program to rise awareness of personnel
- Operational – Cluster 6: Management and organisation
- Operational – Cluster 8: Noise reduction

The risks for rail access liberalisation are derived from the determined qualitative categories of measures' impacts, which were presented in D6.

The main risks that really affect the progress of liberalisation process are mainly caused by the centralised decisions, because they generally represent common objectives over the individual, where market actors are either not interested in these objectives or stand for marginal interests. Many of the EE/EF regulations are centrally initiated by the European Commission or industrial/societal lobbyists, thus this kind of measures shall be in focus in the further analysis.

Within the technological clusters, a couple of measures from the cluster "Reconditioning / revamping of vehicles that already exist" may have the largest internal impact on the railway

market. Reconstructing the combustion and braking systems to reduce exhausting pollutants and noise annoyance, thermo-efficient construction of vehicles, may substantially influence the newcomers' potential to the market access. Particularly if they lack capital that could be invested in such fields. The other selected clusters ("Optimisation of comfort functions"; "Improvement of traction equipment efficiency"; "Reduction of energy consumption") are expected as groups of optionally applied measures in awarding processes. In this case the access to network for newcomers is not depending on possessing these attributes or not, but this can be a ranking factor.

The selected clusters of operational measures show a diversified picture. While training programs expectedly have no impact on the network access, management and organisation initiatives partly may lead to decreased operational costs and indirectly to strengthening competitiveness of the railway sector – important to note that lack of proper financial resources may lead to a converse situation in the rail market. For example noise reduction via differentiated track access fees may have a large impact on investments and operation of TOCs but, due to higher service fees, worsen the cost competitiveness of the railway sector compared to other transport modes.

All the risks revealed in the analysis can be handled by proper risk management techniques. Overall aim is to save the total market potential of the railway sector when implementing such measures in the awarding processes. Anyhow, decision makers in Ministries or at PTAs shall consider that similar EE/EF objectives shall be defined also for other actors of the transport sector. If this was not a realistic demand from this side, efficient and dedicated financial support programs for the railway sector could ease reaching the EE/EF objectives (similar to some initiatives for transport mean reconstruction in the inland waterway sector). Preliminary market research and survey may reveal readiness and resolve of TOCs to achieve such conditions. When the market acceptance of any measure reaches a defined level, it is expected that fulfilling such requirement will become a norm among market actors. Before this status, compulsory implementation and application of the measure is not advisable, but optional operation may indicate follower attitude among market actors. By all means, showing up direct cost saving may contribute to higher acceptance of these measures at companies.

4.12 Environmental and safety consequences

A relation between the presence of safety risks and the technology's status of development is observed: the solutions with safety risks are often under testing or R&D technologies. For these solutions, safety problems are probably not yet worked out.

Environmental risks are mainly related to recycling matters of new materials involved.

One must also consider that some of the analyzed technologies are not already in use but only advertised by manufacturers. So it's important to keep into account that some risks (for safety and environment) could have been voluntarily left out.

4.13 Availability in the market

At least the 43% of the technologies refers to technical solutions which are already available in the market or even used. Cluster 11 (unconventionally propelled vehicles) represents an exception: the technologies in this cluster refer to recent studies so the majority of them are still under testing. Anyway, this kind of technologies does not seem to have so much future success in regional or suburban transport.

When it comes to the operational measures, a majority are already available in the market. Cluster 8 (noise reduction) represents an exception: in this cluster there is the measure "Identification of noise and wheel flats by trackside check points". Such a measure is under testing in several countries because it is quite particular: it is an operational measure with technical implications and it is complicated also from the monitoring system point of view. This cluster contains also the measure "noise-driven procurement", and for that no data about its "status of development" are available: this can be explained by the ambiguity of such solution. It is not so clear if and how the interest in noise emissions beyond the legal limits is pursued by local authorities.

4.14 Economical consequences

Analysis of the technologies and operational measures within WP2 shows that only one third of the short-term technologies and 6 % of the operational measures will mean medium or high operating and/or investment costs. When it comes to long term horizon technologies the share is somewhat higher with about 46 % meaning medium or high operating and/or investment costs. At the same time about 2/3 of the technologies (short term as well as long term horizon) and operational measures will give significant reduction in the vehicle running costs.

The results within WP 2 also show a significant relation between the use of technologies in the real environment (i.e. the local rail transport market) and the absence of economic risks. The potential future technologies, although very promising, need a certain amount of work to be done, e.g. further granting for R&D and study phases, or have to be accepted by the market, which until now revealed a low potential. Furthermore, the analysis has evidenced that some of the technologies and measures can arise economic risks for the TOC, among which the rise in operating costs and less attractiveness to new comer operators of the rail market itself. Finally, a small part of technologies may have negative effects on the attractiveness to the public of rail transport.

4.15 Legal consequences

The results within WP2 show a significant relation between the use of technologies in the real environment (i.e. the local rail transport market) and the absence of legal constraints. The potential future technologies, although very promising, need a certain amount of work to be done, e.g. towards reaching the consensus of the infrastructure managers. When it comes to operational measures, the legal consequences should not be neglected, some measures with a low requirement for investment can nevertheless show requirements for agreements with trade unions and/or the necessity to verify safety issues, up to the necessity to modify the safety certificates.

Part II

5. Considerations about energy efficiency and different legal frameworks and / or awarding methods

- *Can EE and EF criteria be used in all relevant methods of awarding?*
- *To discuss whether certain awarding methods have advantages compared to other awarding methods*

Finally an assessment is intended (deepening the pros and cons see Part I Chapter 4)

Part II

6. General advices for the use of the guidelines under the legal framework in other than the participating countries

(...)

Part II

7. Considerations for the adjustment of European and national law in terms of energy-efficiency criteria

(...)

(Among other points: Considerations referring to the application or adaptation to the European and national legislation with a view to supporting and developing the railway transport which meets the energetic and environmental criteria, as compared with other means of transport.)

Part III: Core Part of the Guidelines

0. Steps for integrating environmental criteria in awarding procedures

All awarding projects, be it for services or for the procurement of rolling stock, can be structured in seven phases according to the following chart. Although the phases given below follow a typical competitive tendering procedure the phases are more or less the same even for quote requests or direct contracts. In all of these phases environmental criteria (including energy efficiency) should be considered as an integral part of the process. On the other hand, all phases including F and G should be kept in mind when environmental criteria are chosen and defined. That means that it does not make sense to use a criterion which cannot be defined in a legally sound way or monitored to a sufficient extent.

Main phases of awarding projects

	Main phases at PTA:	**Main associated actions at PTA:**	**Actions concerning environmental criteria**
A	Preparation	Identification of needs & options (e.g. baseline & scenario calculations)	• Analysis of actual situation (environmental performance) • Identification of main environmental problems • Draft definition of targets in terms of energy efficiency, noise and pollutants • Draft prioritisation and weighting • Decisions concerning new, refurbished or existing rolling stock
B	Elaboration	Preparation of tender / direct contract text plus planning of phases D-F	• Market analysis (technological potentials, economic and legal restraints) • Clear definition of environmental criteria (requirements, target values, performance specifications, incentives...) • Analysis whether and how the criteria can be evaluated, validated and monitored • Definition of priorities and weighting against other criteria
C	Response to tender / quote request	None (bidding operators / suppliers to work)	
D	Evaluation and awarding	Evaluation, decision and justification	• Evaluation of offers in terms of environmental criteria • Assessment whether the selected offer is realistic and reliable in terms of environmental performance
E	Negotiation	Further negotiations and specifications; preparation of final	• Definition of more detailed specifications if necessary • Definition of verification and monitoring procedures • Detailed definition of incentive or bonus / penalty regimes according to the

		contract	performance offered by the bidder
F	Preparation of contract period	Verification of performance with selected operator / supplier	• Verification of environmental performance as far as it is possible before starting the operation (especially vehicle design) • Test runs for the verification of energy consumption
G	Follow up during the contract period	Monitoring and bonus / penalty awards on annual basis	• Monitoring of real-life energy consumption • Verification and monitoring of operational measures • Verfication measures as in phase F if further procurement or refurbishment is foreseen during the contract period • Verification nd monitoring if environmental performance is affected by maintenance or refurbishment • Identification and overcoming of obstacles for better environmental performance (in co-operation with the bidder when appropriate)

Part III

1. General comments on the use of the criteria described below

A PTA which wants to award energy efficient railway services or to procure energy efficient railway tractive units (locomotives or multiple units) may use different kind of criteria. We propose direct indicators, indirect indicators, technologies (or technological clusters) and operational measures. In this chapter we generally describe these kinds of criteria and show the advantages and disadvantages. In chapters 2 and 3 we give some general advices how to apply our recommendations and criteria to different types of contracts or operations. In the subsequent chapters we will describe all criteria in detail according to a logical structure. We propose text modules which reflect the legal situation of public bodies procuring services or rolling stock.

The most elegant criteria are direct indicators. A direct indicator shows directly the energy consumption (measured usually in kWh) of a traction unit in relation to a unit which refers to transport performance or operational performance. In most cases we recommend to use “kWh per seat km” or “kWh per train km”. The indicator “kWh per gross tonne km” can be appropriate when locomotives are procured or analysed independently from the train consists they are supposed to haul.

The big advantage of using direct indicators in awarding procedures is that it is left to the TOC or to the vehicle supplier with which technologies or solutions they want to reduce the energy consumption. Generally speaking, the use of a direct indicator is not only the most elegant, but also the most legally secure way to integrate the energy efficiency in procurement procedures for vehicles and in awarding procedures for Public Service Contracts in passenger rail services. The reason is that, if you use an indicator, the providing company has the choice to develop and present its own solutions whereas, if a particular technology is prescribed, other solutions will be excluded and providers may consider themselves discriminated. Another argument may be even more important and that is that in the field of energy efficiency it is not yet clear which solutions will prove to be the best ones in the middle- or long-term run. In order not to hinder this process of seeking it is advisable to use indicators wherever it is appropriate. Furthermore, such direct indicators show the interdependent result on an ensemble of aggregates, technologies and solutions of the fleet while the positive result of a specific solution could be balanced by a not very intelligent combination with other features.

Unfortunately there are some methodological restraints which should be respected. A standard test cycle for the evaluation of the energy consumption of a railway vehicle does not exist, and it would not even be meaningful to define a single standard test cycle as the operational conditions differ very much between networks and operations, and the rolling stock should usually be optimised for specific types of services. In order to get meaningful results when comparing the energy consumption of e.g. different types of trains, it is essential to make sure that the side conditions are harmonised to a sufficient extent. Among others the following side conditions may be considered: timetable, gradients, ambient conditions, curves, quality of infrastructure, occupancy, comfort functions and passenger comfort definitions. Details are given in chapter 4 of part III of the Guidelines.

But there are situations and considerations when it is not possible, not meaningful or not sufficient to use direct indicators. Therefore we propose to also consider indirect indicators or requirements for solutions, technologies or clusters.

An indirect indicator describes a property of a vehicle which has a relevant or even decisive influence on the energy consumption of a train but does not describe the energy consumption itself. Typical examples for such direct indicators are “weight per seat” or “rolling resistance” per seat. These criteria are obviously the most outstanding ones when passenger carriages for loco-hauled trains are to be procured independently from the locomotives or with the future perspective of being operated with other locomotives. Also in this case the passenger comfort functions must be defined (e.g. distance between seats, calculation of multi-purpose areas etc.). A second disadvantage of these direct indicators is that it does not suffice for comparing loco-hauled trains and multiple units in terms of energy efficiency. For this purpose, direct indicators fit better but the calculation should include the locomotive on the side of the loco-hauled train.

Despite of the advantages of indicators, it may be helpful to also use technological criteria which usually means to require special equipment for the rolling stock. The purpose would be a. o. (1) to assure that a certain level of energy efficiency will be reached, (2) to bring forward the development of certain technologies (e.g. energy recuperation on diesel trains), or (3) according to specific situations in terms of infrastructure. These purposes differ individually between the technological criteria described below (see chapters 6 sqq.). Furthermore, the knowledge of the technology which is available in order to enhance energy efficiency, helps the PTA to forecast or at least assume what results can be achieved by using energy efficiency criteria in the awarding. Some information will be given in the following chapters but for more detailed analysis please use the technical documents of the ECORailS project, provided on the website www.ecorails.eu.[11] If the providers offer different solutions for the same technological problem, specific performance indicators may be appropriate to evaluate these solutions. These specific indicators are described in the respective chapters.

Operational measures can be applied independently from the type of rolling stock although the actual results may differ. Operational measures aim at a more energy efficient use of the vehicles. The most prominent example is “energy efficient driving”. Energy efficient driving styles base upon running smoothly without braking and accelerations more often than necessary and without running maximum speed when the train is on time. Operational measures may require additional features of the rolling stock, e.g. energy meters and certain control functions but these can usually be fitted without major changes to the vehicles. Operational measures provide a considerable potential for saving energy and can also be applied when old or second-hand vehicles are used. On the other hand, some pre-conditions in terms of timetabling, quality of infrastructure or training are usually necessary for operational measures.

All types of criteria mentioned above have their advantages and disadvantages and can be used in specific contexts or for specific purposes. All these types of criteria are useful for a comprehensive strategy for an energy-efficient passenger rail transport and should be combined in a well defined way when an awarding project is being planned.

[11] Please see especially the Deliverables D 6 (“...”), ...

The chapters 4 – 10 comprise the main comments and "technical" advice of the Guidelines in terms of indicators and technology to be described. For each criterion we use the following structure:

1) General description of the criterion
2) State of the art concerning this criterion including potentials and limits in terms of the positive ecological effects
3) Pros and cons, potentials and limits of the criterion in terms of methodology and technology (including relevant negative side effects)
4) Pros and cons, potentials and limits of the criterion in terms of legal and economic framework (including relevant side effects)
5) Performance indicator(s) if the criterion refers to a specific technology, cluster, feature etc. and is not an indicator in itself
6) Detailed and exact definition
7) Legally secure text module
8) Comments on the use of the text module
9) Advices and comments of evaluating the offers in terms of the criterion in question; including the weighting compared to other criteria of awarding
10) Advices and comments of monitoring the performance of the TOC or the vehicles in terms of the criterion in question.

Please be aware that the following chapters are in some cases not yet structured according to the concept given above. This will be done during the further elaboration process.

We propose "legally secure" text modules because there is some concern on the side of the PTA's that inconsiderate wording may cause conflicts with national or European law on tendering or contracting out by public bodies. The text modules we propose are checked against the requirements of the actual European law and the national laws of the countries participating in the ECORailS pilot applications (i. e. Denmark, Germany, Romania and Italy). The relevant law is analysed in part II of these Guidelines. Nevertheless, please be aware that the European or national legislation may change or that combinations of different criteria, be they presented in these Guidelines or deriving from other documents, may cause conflicts. Therefore neither the ECORailS consortium nor one of its partners will accept any liability for causes or legal disputes which may originate from the use of these text modules. We are convinced, however, that these text modules, together with the analysis of the legal situation (see part II) and technical information provided in these Guidelines, will enable all PTA's of the EU to use criteria related to energy efficiency or other environmental effects in a legal secure way.

Please be aware that this document is the first draft of the Guidelines. The detailed confirmation that the proposed text modules are appropriate to the national law of the participating countries and to the practical needs of the PTA's is part of further elaborations of ECORailS, especially of the Work Package 4 "Pilot Applications".

The aim of our project and the Guidelines is to accelerate the process of innovation within the railway industry, especially in terms of energy consumption and environmental effects. It is, however, not realistic to *require* technological or energy efficiency standards in awarding procedures, which are not yet certain to be available on the market at reasonable prices and reliability. This could lead to the withdrawal of a tender and thus to considerable political, economical or legal problems. Therefore we recommend to analyse which standards and technologies are certainly available at the time of starting the awarding project. Within the scope of ECORailS we will provide information about the present technological situation but new solutions are under development and the railway supply industry may have solutions in mind which are not yet known to the public. As a general advice we propose to use both, binding requirements where a certain standard can obviously been achieved, and incentives for the invention of more enhanced technologies in order to go beyond the existing standards and technology in terms of energy efficiency and environmental performance.

To be added:
Short list with the most essential criteria, first proposal:

- kWh per seat km (or per train km or per gross tonne km for special purposes)
- Stand-by and comfort functions
- Energy-efficient driving and driver training
- Energy recovery / storage of energy
- LCC

Indicators and methodological approach for technologies and operational measures qualification

In the preliminary version of chapters 6 sqq. (see below) the following terms are used or the further analysis of the proposed technologies:

Energy savings potential

This item refers to the energy saving for a single vehicle. It has been estimated, by specifying a range of possible values (without using fixed values and fixed ranges) from worst to best case taking into account the different foreseeable application contexts.

The estimations of the potential are based on the evaluations already available in technical literature, on partners' expert judgements and on evaluations in previous and ongoing projects (EVENT, TRAINER, Railenergy).

Pollutants emissions saving potential

This item refers to the pollutants emissions saving for a single vehicle. It has been estimated, by specifying a range of possible values (without using fixed values and fixed ranges) from worst to best case taking into account the different foreseeable application contexts.

The potential estimates are based on the evaluations already available in technical literature, on partners' expert judgements and on evaluations in previous and ongoing projects (EVENT, TRAINER, Railenergy). Also a simulation tool, based on the Railenergy guidelines, has been used.

Economic potential
Economic potentials (on LCC basis) have been evaluated by the following approach:

- Implementation Cost (IC): it represents the initial investment in onboard equipments and/or in infrastructure changes required by the technology or operational measure. The possible values of economic potentials are:
    - High: > 1% of initial investment of the vehicle
    - Medium: 0,1% ÷ 1% of initial investment of the vehicle
    - Low: < 0,1% of initial investment of the vehicle
- Operational Cost (OC): it is represented by vehicle running costs directly caused or influenced by the technology or operational measure (energy cost and costs for operating personnel)
    - Higher→in comparison to a situation without the technology/operational measure implementation
    - Similar→in comparison to a situation without the technology/operational measure implementation
    - Lower→in comparison to a situation without the technology/operational measure implementation
- Maintenance Cost (MC): this category includes all costs to repair failures and/or to prevent potential problems that could compromise operational service. These costs include materials and technical personnel costs.
    - High: > 1% of initial investment of the vehicle
    - Medium: 0,1% ÷ 1% of initial investment of the vehicle
    - Low: < 0,1% of initial investment of the vehicle
- Disposal Cost (DC): costs related to the end-of-life of technical equipment. This category includes demolition, disposal and selling off costs.
    - High: > 1% of initial investment of the vehicle
    - Medium: 0,1% ÷ 1% of initial investment of the vehicle
    - Low: < 0,1% of initial investment of the vehicle

Implementation time
It involves:

1. development time for the availability in the railway market
2. administrative time for the procedures to issue purchase orders to acquire specific equipments involved by a technology or by an operational measure; in particular it involves:
    - financial time→ availability of financial sources
    - technical
    - legal→ due diligence set of regulation
    - management→ acceptance of environmental responsibility
3. construction time for the specific equipments involved by a technology or by an operational measure;

4. installation time to assembly the specific equipments.

The proposed ranges for total time horizon are:

- Short time: < 1 year
- Mid time: 1÷5 years
- Long time: 5÷10 years
- Perspective: > 10 years. This latter category should refer to those measures that are good solutions in general, but the guidelines should handle these measures separately, because these do not yet contribute to the general objective of the ECORailS project.

Interdependencies and contradictions between solutions

The table below represents the attitude of each solution to be implemented with the other solutions considered in this catalogue. At this stage, only qualitative judgements have been expressed and the following convention has been used:

+	It is profitable to implement the solutions together; in some cases it is possible to achieve higher potentials than the sum of the potentials of each solution.
0	The solutions are independent from each other. Implementing the technologies/operational measures together causes neither advantages nor disadvantages: the total saving potential is the sum of each solution potential.
-	It could be not profitable to implement the solutions together: In some cases it is possible to achieve lower potentials than the sum of the potentials of each solution.

	Control of comfort functions in parked trains	On board use of braking energy in diesel-electric stock	Braking energy recovering by super-capacitors as on board equipment	Braking energy recovering by super-capacitors in fixed installations	Energy efficient driving by low-tech measures
Control of comfort functions in parked trains		**0**	**0**	**0**	**0**
On board use of braking energy in diesel-electric stock			–	–	–
Braking energy recovering by super-capacitors as on board equipment				–	–
Braking energy recovering by super-capacitors in fixed installations					–
Energy efficient driving by low-tech measures					

Part III

2. Application to different types of contracts

2.1 Options of integrating ecological standards in awarding procedures

Integrating ecological standards in awarding procedures demonstrates that quality and awarding procedures go well together. Awarding procedures can ensure that technical standards which are available in the market will be established to guarantee ecological improvement, e.g. reduction of noise and emissions as well as energy consumption. Furthermore, due to neutral technical requirements for emission limit values, awarding procedures can stimulate competition in the technical market. The awarding procedure will be described in the following section

2.2 Description of the awarding process

The PTA as a contracting authority has procurement autonomy. This means that it is basically free to determine the requested scope of performance as long as direct and indirect discrimination do not occur while transparency and equal treatment are ensured. Based on the situation in the respective country, the PTA can either be responsible for the awarding of services and/or the awarding of vehicles. The awarding of services can be conducted either through direct awarding or competitive tendering. In both cases, rolling stock can be provided (and procured) by the TOC or the PTA. The inclusion of EE/EF criteria in awarding can therefore, from the PTA point of view, be included either in 1) the service contract or, 2) in the case of PTA owning the vehicles, in the awarding of vehicles.

As described in the legal chapter (chapter 4) direct awarding is still possible. Indeed, this procedure is less non-discriminatory than a tender. However, it should be done in a transparent way with regard to formal requirements of European and national law. Nevertheless, the PTA is permitted to require EE/EF criteria also in direct awarding. Either the respective criteria are required mandatory or the PTA and the TOC arrange them during the negotiation process. The publication of the used EE/EF criteria in the tender documents and their evaluation is often substituted by the negotiation process. But the monitoring is in both cases identical.

How to include EE/EF criteria in a tender will depend on the following situations:

1. Awarding of services, rolling stock provided by TOC
2. Awarding of services, rolling stock provided by PTA
3. Awarding of rolling stock by the PTA
4. Awarding of rolling stock by the TOC

Although the case of number 4 is not within the main scope of the ECORailS project, some of the examples covered in case 3 are of course relevant also when TOC are awarding vehicles. Ways to include environmental criteria when awarding rolling stock have also been well described in the PROSPER project.

Before starting the tender procedure the PTA has to come to a decision regarding e.g. the operational area, the type of vehicles, the kind of services and appropriate limit values. The criteria have to be just and reasonable for all bidders. To monitor and evaluate the standards, the complexity and costs of the measurement of the vehicles have to be quantified. For the PTA it is also important to be informed about the terms and conditions of loan programmes for vehicles with high ecological standards from other public institutions, national or European authorities. Also potentially raised questions concerning admission premises e. g. from railway supervisory authority can be relevant and have to be considered by the PTA. To ensure a fair tender procedure the advantages of vehicle grants have to be considered for the assessment of bids.

After clarifying these questions the awarding documents can be prepared.

In order to establish ambitious ecological standards in the tender procedure, two elements are important to stipulate in the awarding documents: First, high ecological standards are defined as minimum standards. The minimum standards base on the state of the art, prices and the prospective limit values. The compliance with these standards is mandatory for the bidders and has to be strictly monitored during the duration of the service contract. It has to be clear to the bidders that a breach of the minimum standards will cause sanctions which will be fixed in the service contract. A draft of the contract is a mandatory part of the awarding documents. Secondly, tender responses with advanced ecological standards receive a higher scoring due to bonus points at the assessment. These advanced ecological standards have to be monitored as well.

The criteria for the assessment have to be described in the awarding documents. Usually the price per year (extrapolated from the length of the service contract) is the most important parameter. One possibility to include ecological standards in the assessment is to monetize and weight these standards and to add them to the assessment criteria. Therefore, the PTA has to differentiate between the minimum standards and advanced ecological standards. A bonus is given if the minimum and/or advanced level is exceeded.

In the contracts analysed in the interviews, the most common criteria besides the price were criteria concerning the quality of the services. For example in Italy (Lombardy) the capacity offered during peak-hours were weighted by 10%. In the Danish “Øresund” case, the quality criteria were in total valued with 30 % of the offer. One example of including EE/EF in the evaluation process was identified. In the evaluation of the tenders for the “Netz Stadtbahn“, environmental criteria were weighted by 2%. This included data concerning noise, emissions and environmental concept (including information on aims, technical methods, measurable achievements for energy retrieving, environmental management and recycling).

Incentives and/or penalties are rather commonly used today in service contracts and usually include criteria like punctuality, growth in number of passengers etc. The argument for including incentives or penalties is to promote (or prevent) a certain behaviour. This could be a way to reduce energy consumption or to reduce the emissions from diesel vehicles. However, in the interviews for this study, no examples of incentives concerning EE/EF criteria were found. One reason for this is the lack of an accepted common indicator for energy efficiency. The energy consumption of a train also depends on many factors, not only related to the train performance and its maintenance/efficiency state. Some of them are: the plane-altimetrical layout of the specific line, the load due to the real number of passengers on board, the planned acceleration and deceleration phases, the environmental conditions (mainly for the energy consumption due to the equipment of comfort functions as ventilation, heating and conditioning).

Requirements are criteria that the TOC or manufacturer need to fulfil as minimum standard in order to be qualified for the contract. The evaluation of a requirement is easier compared to the evaluation of incentives and weights since the TOC either fulfils the criteria or not.

From a technological point of view three cases of the use of requirements could be considered:

- inclusion of requirements for operational measures in the awarding procedure for services
- inclusion of requirements for vehicles in the awarding procedure for services
- inclusion of requirements for vehicles in the awarding procedure for vehicles

The third option represents an important issue because in many countries, in order to liberalize the railway market, several regional PTAs have been purchasing their own rolling stock recently.

In this case, PTAs can demand the requirements for the implementation of a specific solution as it happened in the past in some countries, when the railway companies defined technical specifications on operational measures and rolling stock and the industry just maintained manufacturing responsibility. Today PTAs could just request compliance with some parameters (e.g. LCC, weight, energy consumption) leaving it to the industry to find the appropriate solutions or stimulate the manufacturers to achieve better performances for well defined parameters.

When the rolling stock belongs to the PTA and the TOC operates these vehicles, it is also relevant from a technological point of view how the maintenance aspects could be integrated into the service contracts, in particular who performs the general overhaul of vehicles and who pays for this. These aspects could be relevant in particular for diesel engines where a bad maintenance by TOC could cause more pollutants emissions, energy consumption and costs for the general overhaul.

Part of the awarding documents is the request to prove the environmental standards by the bidder (if the rolling stock is not provided by the PTA). This can be done e. g. by documented evidence of used vehicles, by confirmation of the manufacturer that vehicle technology is effective and limit values will be adhered to. Accompanying measures could also include a professional training for energy-efficient driving.

After developing the awarding documents the PTA has to publish the tender-documents in the Official Journal of the European Union. In addition to the specification of services and the assessment criteria, the tender floating period and the bid adjudication period are part of the publication.

Within the bid adjudication period questions from the tenderers are allowed.

Once the bids are received they are reviewed with regard to the financial and technical qualification and certifications. The assessment of the bids also includes the prices and the compulsory ecological standards. As a result the most economical bid (in terms of cost-

performance ratio) is accepted. It is important that the accepted tender not necessarily is the cheapest tender in terms of the “real price”. If the tender wins many bonus points due to its advanced ecological standards it may perform better in the assessment than cheaper tenders.

The bidder is notified that his bid has been accepted. The notification also has to be published in the Official Journal of the European Union. A verification procedure of the awarding procedure is possible.

Experience shows that the requirement of ecological standards, which exceed the current regulations is generally accepted by the bidders. Also the better assessment of the bids with ambitious environmental standards in the bid evaluation is commonly accepted, if the tender documents give a clear and calculable picture on the assessment criteria.

As a precondition, availability and affordability of suitable vehicles to satisfy the limit values must be given. A disadvantage for a potential bidder could arise if a train operating company (TOC) was bound by contract or tradition to a special vehicle manufacturer and if this manufacturer was not able to deliver rolling stock with the required specifications. This clearly points to a functional tender which does not specify a certain technology to reach the standards and which gives ample scope for technical options for the bidders and vehicle manufacturers. A specification of certain technologies makes a justification by the PTA necessary. However, a non-binding indication of filter technologies to comply with limit values is generally non-critical for the PTA.

The integration of ambitious environmental standards raises the costs of the bid preparation by the bidders. The planning effort during the tender floating period is higher since infrastructure planning and the risks involved are added to the “regular” tender planning. However, if the awarding sets innovative environmental standards and if satisfaction of the standards cannot be proven by previous awarding procedures, it is essential that the PTA thoroughly and in time acquaints itself with available technology with regard to the preparation of the awarding documents.

That knowledge enables the PTA to keep the standards up during the whole duration of the awarding procedure. Furthermore, the definition of services and standards enables the PTA to avoid the trade-off between low-priced bids and low environmental or social standards.
In summary it can be stated that

- ambitious ecological standards can be set and enforced by awarding procedures;
- transparent assessment criteria allow for an assessment of the environmental quality offered in a legally compliant way;
- grant programmes and fair competition are compatible if grants are made available to all participants of a competitive awarding procedure in a non-discriminatory way.

2.3 Application to different methods of awarding services by the PTA

To include EE/EF criteria in awarding of services the following “legal tools“ are available.

- Requirements – The TOC is required to fulfil the included criteria.
- Incentive – The TOC can be granted an incentive if it manages to fulfil the criteria, can be through economic compensation or extension of contract.
- Penalty (or negative incentive) – The TOC will have to provide penalties (reasonable and proportionate) for non-compliance to the criteria included in the contract. In case of subsidies, this can be through deducting from the economic compensation.
- Weight – Criteria can also be used for evaluation of the tenders and be weighted together with price and quality parameters.

The last bullet point is only relevant within a competitive tender procedure whereas the other three are independent of awarding procedure.

In general, technologies or levels of energy consumption should be included as requirements for the vehicles that are to be used for the services. For awarding of services this is therefore mainly relevant when vehicles are provided by the TOC. If the PTA is the owner of vehicles this is to be included in the awarding of vehicles. However, certain technologies and measures could also be suitable to include as non-mandatory criteria and weighted in the evaluation of tender. In this case, a TOC which provides vehicles equipped with a certain technology will be weighted higher than a TOC which does not offer this.

Direct and indirect indicators could also be included as an incentive/penalty based system as well as requirement and as a weight criterion if the tendering is done through a competitive procedure.

2.4 Further open points:

- *Procurement of rolling stock via leasing companies*
- *Modernisation path (that is a UK model: the state or leasing companies own old vehicles. TOC’s can use it, but have to use a new fleet after a timeframe of some years)*

Part III

3. Application to different types of operation

(...)

- Diesel operation, loco-hauled / DMU's
- Electric operation, loco-hauled / EMU's
- Different service profiles (acceleration, speed)

Part III

4. Direct indicators (traction energy consumption)

4.1. General description

Direct indicators[12] describe the overall result of all efforts to reduce the energy consumption of specific train services. Using direct indicators means that criteria regarding energy efficiency are included in the awarding procedure without referring to a single technology or operational measures, although requirements in terms of equipment and/or operational measures might be used additionally. In the context of ECORailS, a direct indicator shows the energy consumption of a traction unit in relation to a unit which refers to transport or operational performance. The unit of the enumerator is "kWh" (kilowatt hours) while the denominator is given as (e.g.)

- *passenger km*
- *seat km*
- *train km*
- *gross tonne km*

To reduce the consumption of ***"kWh per passenger km"*** is, of course, the indicator which is the most relevant in terms of climate protection, in terms of the environmental comparison of transport modes and in the political discussion about transport modes. It is also the strategic aim of the ECORailS project to reduce the energy consumption per passenger kilometre and thus to enhance the competitiveness and the environmental performance of passenger rail transport. In spite of that, it does not seem to viable to use this general indicator in an awarding procedure it is highly related not only to the technology and intelligent operation but also to the occupancy. The latter depends to a great extent on conditions which are not in the scope of the TOC's responsibility. Also the PTA may have great influence on for the occupancy, because it is, at least partially, the PTA's responsibility to invent passenger-friendly service concepts, negotiate with the infrastructure manager (IM) etc. Incentives for achieving higher occupancy should be given to the TOC separately from incentives to reduce the energy consumption.

The indicator ***"kWh per seat km"*** will be the most appropriate one for most applications in the context of awarding rail passenger services, as it can be applied to (the comparison of) different types of trains and operational concepts. It is clear that some side conditions should be defined with respect to the convenience of the passengers, e.g. seat pitch, width of seats and the calculation of multi-purpose areas, corridors, restrooms etc. But these definitions have to be made anyway, independently from energy consumption matters, when a PTA is asking for bids, because the number of seats in a given car body has relevant implications for both the passengers' comfort and economics. However, the calculation, simulation and verification of "kWh per seat km" will usually base on the value "kWh per train km" and then calculated according to no. of seats etc.

The indicator ***"kWh per train km"*** can be used if class and configuration of the train compositions are defined very clearly. It is obvious that trains may otherwise consist of 2, 3,

[12] In the PROSPER project the term "performance value" was used. This term is to be seen as more general and could include "direct indicator" and "indirect indicator" as well as values for noise or exhaust emissions.

4 or more coaches with very different levels of energy consumption. Additionally the standard designs of multiple units offered by the vehicle suppliers may differ at least slightly in terms of length, width and space for passengers. So this indicator may typically be used if the PTA provides the rolling stock and/or has very clear specifications about the train capacity. In this case the vehicle suppliers may offer their standard designs and if they have more capacity than required, usually implying more weight of the train consist, this may be balanced by energy efficient traction technology. So this indicator may be useful in certain situations. However, it should be considered that in times of high transport demand trains may consist of two or even more multiple units or loco-hauled compositions. In these cases the calculations should be based on single train sets but the supplier should guarantee that double or triple units do not cause disproportionate increases of energy consumptions due to inappropriate control functions. The indicator "kWh per train km" is, however, the base for the calculation of "kWh per seat km" (see above).

When it comes to passenger transport the indicator ***"kWh per gross tonne km"*** only makes sense when locomotives are to be procured independently from the carriages the locomotives are supposed to haul. "Gross tonne km" describes the weight of the train without the locomotive[13], multiplied with the distance the train is hauled. If fixed train compositions are considered, the indicator "kWh per seat km" should be used at least additionally. Thus it is also possible to compare loco-hauled trains with multiple units. As with "kWh per seat km" the actual values can be simulated and verified on the base of tests or simulation with trains. Then "kWh per train km" can be converted to "kWh per gross tonne km".

In order to get meaningful results when comparing the energy consumption of e.g. different types of trains, it is essential to make sure that the side conditions are harmonised to a sufficient extent. Among others the following side conditions may be considered: timetable, speed limits, gradients, ambient conditions, curves, occupancy, comfort functions and passenger comfort definitions. These variables are not to be neglected as differing definitions of side conditions in a simulation may lead to bigger differences in the calculated energy consumption than the difference between the energy consumptions of two different classes of traction units actually is in reality.

4.2. State of the art

A methodology for calculating direct indicators (performance values) is currently under development within the Railenergy project (duration 2006-2010). This is a joint project of UIC, UNIFE and other partners. With respect to the direct indicators used in these Guidelines, at least three approaches of the Railenergy project are relevant:

(1) The definition of Standard Service Profiles (SSP)[14] which can be used to describe the energetic performance of a traction unit or a train independently from a specific network or operation;
(2) A standardised method to describe the service profiles ("defined infrastructure under defined operational conditions");
(3) Compilation of data about the energy consumption of the existing railway fleet according to the standardised methods mentioned above.

(1) The SSPs are a proposed standard, applicable for the specification and verification of energy consumption of new rolling stock, or for the efficiency improvement of existing rolling stock. The criterion used for the energy consumption of rolling stock is the total net energy consumed at pantograph over a predefined operational profile, which is either taken from a

[13] Is this definition correct? How to include the (average) weight of the passengers?
[14] Railenergy, Deliverable 2.2.3 – Definition of standard service profiles, Draft version, 23/07/2008

standardised profile valid for the specific category of trains or from the actual future operation of the train. Six preliminary SSP's have been agreed upon in the Railenergy project which can already be used for the procurement of vehicles or the contracting out of services. Three of them are relevant for regional passenger rail transport:
(a) "Suburban"
(b) "Regional"
(c) "Intercity".
Although the brand "Intercity" is in most countries used for long-distance trains which are run without state subsidies or Public Service Contracts, train services with similar service profiles are awarded by PTA's in many cases (e.g. in Germany, Denmark, Sweden or France).

Alternatively to using an SSP, the PTA or the TOC may use the operational profile of the specific line or network for which the rolling stock shall be used. This allows for tighter calculation of the energy consumption and the costs of the operation and makes it easier to monitor the energy consumption once the service has been awarded. On the other hand it requires some effort to analyse the operations in question and to describe them according to the standardised method (see below).

(2) The Railenergy project is developing a standardised method to describe service profiles which may be the SSP's or the individual ones used by a PTA or TOC for a specific procurement project. The ECORailS project will not develop a competing standard but intends to integrate all relevant elements and to adapt them for the purposes of PTA's where necessary. According to the method developed and standardised by Railenergy, the following parameters have to be defined clearly for the operation of the train ("in-service" mode; "out of service mode" please see chapter III, 8 of the Guidelines):
Infrastructure: longitudinal profile, speed profile, curves, tunnels, electric power supply system;
Diesel fuel: diesel fuel specifications[15];
Operational requirements: train and propulsion system, timetable, pay load, driving style, regenerative braking, comfort functions (in-service);
Environmental (ambient) conditions: ambient temperature, humidity, intensity of sunlight, average head wind.

The methodology for using energy performance values like e.g. "kWh per seat km" is being developed and is assumed to be available in 2010.

Detailed explanations and definitions as well as the Standard Service Profiles, are described in the Railenergy paper "Specification and verification of energy consumption for railway rolling stock", draft of 2009-09-25. This draft is not yet published and can therefore not yet be made available to the public as annex to the draft of the Guidelines. The draft Railenergy documents will, however, be used internally by ECORailS partners for the site studies ("pilot applications") and their usefulness in conjunction with the ECORailS Guidelines will be tested.

(3) Within the scope of Railenergy a lot of data have been compiled about the energy consumption of the existing railway fleet and the data shall be standardised according to the

[15] In the Railenergy papers the „Diesel fuel specifications" are part of the infrastructure description, but this assignment is not followed here.

methods mentioned above. When published, these data will be available as benchmarks for the energy saving potentials of regional rail passenger services.

4.3. Pros and cons, potentials and limits of direct indicators

Generally speaking, the use of a direct indicator is the most elegant way to integrate the energy efficiency in procurement procedures for vehicles and in awarding procedures for Public Service Contracts in passenger rail services. The procedure remains open for offers with differing technologies, solutions or configurations. Using a direct indicator is more legally secure than referring to single technologies since thus there will be less risk for discrimination.

There is no clear counter-argument against the use of such indicators but it implies some efforts by the PTA (or TOC) and some restraints have to be respected:

- For simulation and verification of the energy consumption all relevant side-conditions and parameters have to be clearly described according to the methodology provided by the Railenergy project. These specifications shall be included or referred to in tendering documents, quote requests and contracts.
- It should be checked whether offers and simulations provided by TOC's or vehicle suppliers are really comparable and use the correct methodology.
- It means some considerable effort for the PTA to select and describe the stretch of the network in a sufficient way which will be the reference for comparing or verifying the energy consumption of the rolling stock.
- Defining a baseline for the energy consumption may be difficult because the respective data for the existing fleet are often not available and test runs with the existing fleet are often neither in the scope of a PTA nor justified when the old vehicles are about to be withdrawn. Local railways may have it easier to handle this problem if they can easily relate the energy consumption on their network to the performed train kilometers.

Although the definition of a baseline does not seem to be absolutely essential for using direct indicators for the energy consumption in an awarding procedure, it would ease the assessment of different offers, to check their plausibility in terms of energy data, and to find a reasonable weighting of energy efficiency against other criteria. With a baseline it will be more obvious how relevant the offered savings are, and incentive schemes will be easier to define in advance.

The quantitative potential of direct indicators depends on the available technologies which can be invented by using these indicators and on the technology which is already in use (see chapter I, 4).

When having a cursory look it might seem that the direct indicator was the ideal single value for the evaluation of energy efficiency. But it does not scope the following areas of analysis:

- Per definition (according to the standardised Railenergy methodology) it does not include comfort functions for the passenger compartments. These have to be defined and analysed separately (see chapter III, 8).
- Trains also consume energy when parked for some time between services. This energy consumption is not negligible, but has to be analysed separately from the traction energy (see chapter III, 8).
- It depends on the propulsion concept of a traction unit which driving style can be recommended by the manufacturer as the most energy-efficient one. In simulations and verifications it will be assumed that this driving style is applied. But it is not given

that this driving style will be followed by the drivers in every-day operation, especially if the drivers are not trained or differing driving styles are appropriate for the distinct classes of the rolling stock in operation. So “energy-efficient driving” and “driver training” are considered by ECORailS as essential separate criteria.

- Although it is desirable to monitor the overall energy consumption of the contracted services and to base incentive schemes upon this overall monitoring, this may not be viable in certain cases because their are potential causes for increased energy consumption which are not or not clearly enough in the responsibility of the TOC, e.g. quality of infrastructure, disturbance of timetable by other parties, weather conditions, load factors, losses in the energy supply system. In such circumstances test runs must be done, the driving styles and appropriate maintenance should be monitored.

4.4. Detailed and exact definition

We refer to sub-chapters 4.1 and 4.2 and to the Railenergy working paper “Specification and verification of energy consumption for railway rolling stock”, version of 2009-09-25.

4.5. Implementation time

The relevant methodology and the Standard Service Profiles are already provided by Railenergy although not yet finalised and published. This is expected for 2010. The methodology has already been successfully applied in procurement projects, using specific “home-made” service profiles by the procuring TOC.
We recommend as an essential that PTA’s require meaningful monitoring procedures in their awarding as from now, even if these Guidelines are not applied due to short-term decisions in 2010 or 2011. The results of the monitoring are important for the definition of baselines in future tenders or contracts.

4.6. How to include in awarding procedure

A direct indicator is relevant when awarding vehicles and services. In order to use a direct indicator in awarding, first of all a method for calculating the energy consumption needs to be established and agreed upon. In case of competitive tendering this must be easy accessible for all contenders in order to be in compliance with the non-discriminative principle. Otherwise, the incumbent TOC will have a competitive advantage. Another prerequisite is that for electric traction there is an energy monitoring system available. Depending on the awarding procedure the indicator can then be included in the awarding as requirement, incentive and/or as a weight for the evaluation of the tender.

In order to be legally compliant to European legislation the indicator needs to be described in the awarding document as well as the baseline and the methodology for calculating the baseline. Methods for the calculation of incentives and/or the weight for evaluating also need to be defined and described in order to fulfill the principle of transparency.

If vehicles are provided by the PTA, the TOC has no influence on the energy consumption as far as it is defined by the vehicle design. Nevertheless, the TOC may use operational measures or appropriate maintenance procedures for reducing the energy consumption. The TOC can be motivated to reduce energy consumption through an incentive/penalty system. Procedures for maintenance are then also important and need to be elaborated. In general we have one problem with the direct indicator(s):

For a good calculation or simulation, load factor, weather conditions, quality of infrastructure and compliance to the timetable (a.o.) have to be defined. The reality may, however, outcome quite different. One way to deal with this problem is that the TOC may profit from the incentive even if it is only due to good weather conditions while the TOC would get no compensation if weather and other conditions prevent it from having low energy consumption.

Steps for including in awarding procedure	
Steps independent of awarding procedure	• Establish a methodology for calculation of energy consumption, either based upon real situation from current services or elaborated through SSP. • If existing vehicles to be used and electric traction, energy meters need to be installed. • Incumbent TOC should in contract be required to provide the PTA with data that the concern direct indicator.
Procuring of rolling stock	• Require declaration of traction energy consumption from manufacturer according to the defined methodology • Require energy meter to be installed • Evaluate the tenders in terms of data about energy consumption, based on LCC approach or as weight for evaluation of the tenders

Awarding of rail services, vehicles provided by PTA	• Follow steps relevant for procuring of rolling stock (if existing vehicles to be used - energy meter is required)
	• Include energy use according to the chosen relevant direct indicator as an incentive/penalty system
	  ○ Identify energy saving potential
	  ○ Estimate the value of the contract
	  ○ Construct compensation levels
	• Describe requirements regarding maintenance

Awarding of rail services, vehicles provided by TOC	• Require energy meters to be installed
	• Require energy use to be presented in the tender according to the agreed baseline
	• Include maximum energy consumption of vehicles as requirement
	Or:
	• Include energy use according to the chosen relevant direct indicator as a weight criterion used for the evaluation of the tenders (only relevant in a competitive tendering procedure)
	  ○ Calculate the weight to be used (based on energy costs or political relevance of energy efficiency in relation to total operational costs)
	And/Or:
	• Include energy use according to the chosen relevant direct indicator as an incentive system
	  ○ Identify energy saving potential based on baseline
	  ○ Identify the value of the contract
	  ○ Construct compensation levels

4.7. "Legally secure" text modules

First examples, to be further elaborated at test sites

Example 1 – Incentive (awarding of services)

[present the methodology for calculation of energy consumption]

[present the incentive]

> *"If [direct indicator] are lower than [baseline] for a certain year, the TOC can, if applied for latest the [date] the following year, receive economic compensation for the year specified.*

[describe the calculation method]

> *"Decreased energy consumption [direct indicator] are valued to ____ € per [unit below the baseline]. The maximum level of compensation is ____ € per [unit, i.e. train km and time period] in the awarded service package."*

[describe how to monitor and penalties etc.]

Example 2– weight for evaluation of tender (awarding of services)

[present the methodology for calculation of energy consumption]

[present the criteria]

> *The energy consumption is to be presented in the tender based on energy consumption per [direct indicator] according to the baseline. The energy consumption will in the evaluation be valued to [weight].*

[describe how to evaluate, LCC/Weight]

[describe how to monitor and penalties etc.]

Example 3– requirement, awarding of vehicles, awarding of services, vehicles provided by TOC

[present the methodology for calculation of energy consumption]

[present the requirement]

> *The energy consumption of the vehicle is not to exceed* [specified value] *per* [direct indicator] *according to the baseline.*

[describe how to monitor and penalties etc.]

4.8. Advices and comments for evaluating the offers and the weight of direct indicators

(…)

4.9. Advices and comments for monitoring the performance

(…)

4.10. Compliance to legal framework

Using a direct indicator is more legally secure than referring to single technologies since there will be less risk for discrimination than with referring to a single technology. If a competitive tendering procedure is used, the baseline must be clearly described and accessible for all contenders. Otherwise the incumbent TOC will have an advantage. In order to be legally compliant to European legislation, the indicator needs to be described in the awarding document as well as the baseline and the methodology for calculating this. Methods for calculation of incentive and/or weight for evaluating also need to be defined and described in order to fulfill the principle of transparency.

Part III

5. Indirect indicators

5.1 General description

In the context of ECORailS, an indirect indicator describes a parameter which has a major or substantial influence on the energy consumption of a train but does not describe the energy consumption itself. The most relevant indirect indicator is “weight per seat”. The mass of a vehicle is especially decisive in regional passenger transport with its frequent stops and a high share of energy consumption for acceleration.
The parameter "weight per seat" can be used for the procurement or description of passenger carriages for loco-hauled trains, especially when it is intended to procure or operate them independently from the locomotives.
When it comes to multiple units or the comparison between entire trainsets, the direct indicator "kWh per seat km" should be preferred, but the specific mass could be used additionally as it is easy to measure and verify.

5.2 State of the art

In recent years major progress has been made with respect to mass reduction in passenger railway equipment. Main fields of mass reduction are:

- Lightweight materials and design for carbody and interior equipment
- Smaller and leightweight equipment for traction and auxiliary aggregates
- New vehicle concepts (e.g. double-deck carriages, articulated trains, replacement of loco-hauled trains by multiple units)

Not all of these measures can be applied in a specific awarding project, e.g. for comfort reasons or specific operational conditions.

- Benchmark: examples for values of weight per seat of to date railway rolling stock

5.3 Pros and cons, potentials and limits in terms of methodology and technology

- Potential application and usage
- Energy saving potential
- Implementation time

5.4 Pros and cons, potentials and limits in terms of legal and economic framework

There are no legal or economic restrictions for using "weight per seat" as an award criterion in awarding procedures provided that incentives and/or requirements base on realistic assumptions and the methodological restraints are respected.

5.5 Detailed and exact definition

(...)

5.6 How to include in awarding procedure

- Compliance to legal framework

5.7 Legally secure text module

(...)

5.8 Advices and comments for evaluating the offers

(...)

5.9 Advices and comments for monitoring the performance

(...)

Part III

6. Features and equipment of the vehicles to be used

(...)

6.1 Energy recovery (electric traction)

Cluster Energy recovery: the breaking energy could be recovered and re-used by the same vehicle or by trains running on the same line. The final employments of the recovered energy are essentially two: traction purpose or auxiliary functions purpose.

Part III

6.2. Energy recovery (diesel traction)

Cluster Energy recovery: the breaking energy could be recovered and re-used by the same vehicle or by trains running on the same line. The final employments of the recovered energy are essentially two: traction purpose or auxiliary functions purpose.

6.2.1 On-board use of braking energy in diesel-electric stock

Modern diesel locos or DMUs with electric power transmission can be equipped with the capacity to use some of the energy recovered during braking for auxiliary and comfort functions. In modern diesel-electric 3-phase locomotives the Diesel engine drives a generator feeding the DC link. The DC link feeds the traction inverters as well as the auxiliaries and the train bus supply. During braking, the traction motors feed the recovered power into the DC link. This additional power can either be converted into heat in braking resistors or used for other consumers, namely auxiliaries (compressors, ventilation etc.) or the train bus supply (supplying the comfort functions in passenger trains). The power management is usually performed as follows: The recovered braking power is fed into the DC link. The part of this power that can be used for auxiliaries or train bus supply is drawn from the DC link, the rest is dissipated in the resistors. The resistor is automatically "switched on" if the voltage in the DC link exceeds a certain limit value.
Some suppliers are developing new technical solutions for the storage of energy. Thus the braking energy could be re-used for acceleration. These solutions are, except for super-capacitors, not yet available on the market and are not considered in the chart below.

INDICATORS	POTENTIALS	
Energy savings potential	2-5%	
Pollutants emissions saving potential:		
CO_2 emission saving potential	2-5%	
NO_x emission saving potential	2-5%	
CO emission saving potential	2-5%	
HC emission saving potential	2-5%	
Particulate emission saving potential	2-5%	
Economic potential (on LCC basis):		
Implementation Cost (IC)	Medium	
Operational Cost (OC)	Lower (decrease of 15% for energy)	
Maintenance Cost (MC)	Low	
Disposal Cost (DC)	Low	
Implementation time:	**description**	**years**
Development time	Status of development: in use	<1 year
Administrative time:		
○ Financial	This could be a bottleneck, depending on the country.	<1 year
○ Technical	The use of recovered brake energy for on-board purposes in diesel-electric stock is a very promising energy saving measure for passenger operation. There are virtually no additional costs and barriers. Diffusion is essentially limited by the speed of stock renewal. The feature is to be integrated into specification sheets in future purchasing of diesel-electric locomotives. The potential of the feature in DMU stock has to be assessed.	1 year
○ Legal	No legal process linked to the installation of the equipment to use braking energy in a diesel-electric stock.	<1 year
○ Management	On-board use of braking energy in the new rolling stock is a choice of the management policy linked with the renewed fleet and with environmental responsibility.	1-5 year
Construction time Installation time	The construction time for new locomotive equipped for on board braking energy use is similar to others.	<1 year
Total time		1-5 years

6.2.2 How to include in awarding procedure

This technology can be included as a requirement for vehicles which are to be used for the services. In case of PTA providing the vehicles, it is included in the awarding of rolling stock. If vehicles are provided by the TOC it is included in the awarding of services and defined in the Public Service Contract that the vehicles are to be equipped with this technology. The detailed functionality of the energy recovery/regeneration/storage system must be specified in the invitation to tender.

Regardless if vehicles are provided by TOC or PTA, the contenders need to be able to calculate the energy savings potential in order to avoid giving the incumbent TOC a competitive advantage. Therefore, when awarding services through a competitive tendering procedure, the characteristics of the services should also be specified (stops, line profile etc.).

Steps for including in awarding procedure	
Procuring of rolling stock	• Require the relevant technological solution to be installed
Awarding of rail services, vehicles provided by PTA	• In a competitive tendering procedure - In the tendering documents, provide the necessary information for the TOC to calculate the energy saving potential from the technology in order to give all contenders the possibility to include the effect in their tender.
Awarding of rail services, vehicles provided by TOC	• In a competitive tendering procedure - In the tendering documents, provide the necessary information for the TOC to calculate the energy saving potential from the technology in order to give all contenders the possibility to include the effect in their tender. • Require the relevant technological solution to be installed

Legally “secured” text module (first example, to be further elaborated at test sites)

Example 1 – Awarding of vehicles

[Text module]

Require the vehicle to be equipped with [technology].

[Detailed description of the technology]

Example 2 – Awarding of services, vehicles provided by PTA

[Include specification of the services – service profile, scheduling etc.]

[Detailed description of the technology]

Example 3 – Awarding of services, vehicles provided by TOC

[Include specification of the services – service profile, scheduling etc.]

[text module]

The vehicle used for the services is to be equipped with [technology].

[Detailed description of the technology]

6.2.3 Compliance to legal framework

Should be in compliance with European legal framework, but is depending on availability of technology (manufacturers etc.). Important that every contender knows about the effect of energy saving potential in order to avoid giving the incumbent TOC an advantage.

It could also be difficult for the PTA to include this technology in awarding, since it requires knowledge about the technology.

Part III

Chap-ter	Sub-chap-ter	Title, keywords	Responsible for contribution /elaboration (proposed)	Necessary for 1st and 2nd draft?
	6.3	Storage of energy onboard		yes (high priority)

6.3 Storage of energy onboard (Braking energy recovering by super capacitors onboard equipment)

Cluster Energy storage: the recovered energy (e.g. the braking energy) could be stored in several ways: on-board or in fixed installations (see sub-chapter 6.4). Different devices could be employed for this purpose like super-capacitors or batteries.

So far, this chapter has been elaborated only with respect to super capacitors. Comments on other technologies for onboard storage of energy will follow.

6.3.1 Description, advantages and disadvantages

By this technology it is possible to store the energy released when braking and use it during the next acceleration of the vehicle. Each time the vehicle brakes, the energy storage devices (super-capacitors) are loaded again. During the next acceleration, the stored energy is released. This additional energy lowers current demands from the network, for the same traction effort. The technology can be used for both electric and diesel traction (the latter if electric power transmission is used).

Advantages:

- Charges in seconds;
- Double-layer capacitors compared with rechargeable batteries are extremely low internal resistance;
- Extremely low heating levels, and improved safety;
- Good reversibility;
- High cycle efficiency (95% or more);
- High output power;
- Little degradation over hundreds of thousands of cycles;
- Low impedance;
- Low toxicity of materials used;
- No danger of overcharge;
- Very high rates of charge and discharge;
- Virtually unlimited life cycle - cycles millions of time - 10 to 12 year life.

Disadvantages:

- Super capacitors and ultra capacitors are relatively expensive in terms of cost per watt;
- The amount of energy stored per unit weight is considerably lower than that of an electrochemical battery (3-5 Wh/kg for an ultracapacitor compared to 30-40 Wh/kg for a battery). It is also only about 1/10,000th the volumetric energy density of gasoline.
- The voltage varies with the energy stored. To effectively store and recover energy requires sophisticated electronic control and switching equipment.
- It has the highest dielectric absorption of all types of capacitors.

6.3.2 State of the art

Other technologies for storage of recuperated energy are under analysis or development but it is not clear yet how promising they are compared to supercapacitors. It should, however, be clarified whether in the awarding it should be asked onboard storage of energy in general or for supercapacitors in particular.

(See chart on next page)

INDICATORS	POTENTIALS		
	Electric Traction	**Diesel Traction**	
Energy savings potential	20-30%	till 35%	
Pollutants emissions saving potential:	**Electric Traction**	**Diesel Traction**	
CO_2 emission saving potential	depending on energy mix	35%	
NO_x emission saving potential	depending on energy mix	>35%	
CO emission saving potential	depending on energy mix	<35%	
HC emission saving potential	depending on energy mix	<35%	
Particulate emission saving potential	depending on energy mix	<35%	
Economic potential (on LCC basis):			
Implementation Cost (IC)	Medium		
Operational Cost (OC)	Lower (decrease of 20% for energy)		
Maintenance Cost (MC)	Low		
Disposal Cost (DC)	Low		
Implementation time:	**Description**		**years**
Development time	Mature and reliable technology		<1 year
Administrative time:			
○ Financial	This could be a bottleneck, depending on the country.		<1 year
○ Technical	Applicability for railway segments: medium Type of traction: electric – DC; diesel Type of transportation: passenger - regional lines, passenger - suburban lines.		1 year
○ Legal	No legal process linked to the installation of the equipment for use braking energy with super-capacitors.		<1 year
○ Management	Use of energy recovering braking energy by super-capacitors on board equipment is a choice of the management policy linked with the purchase of new rolling stock.		> 5 years
Construction time Installation time	The construction time for new locomotive equipped with recovering storage device with super-capacitors is the same of another type of rolling stock		<1 year
Total time	5-10 years		

6.3.3 How to include in awarding procedure

This technology can be included as a requirement for vehicles which are to be used for the services. In case of PTA providing the vehicles it is included in the awarding of rolling stock. If vehicles are provided by the TOC it is included in the awarding of services and defined in the Public Service contract that the vehicles are to be equipped with the technology. The detailed functionality of the energy recovery/regeneration/storage system must be specified in the invitation to tender.

Regardless if vehicles are provided by TOC or PTA, the contenders need to be able to calculate the energy savings potential in order to avoid giving the incumbent TOC a competitive advantage Therefore, when awarding services through a competitive tendering procedure, the characteristics of the services should also be specified (stops, line profile etc.).

Steps for including in awarding procedure	
Procuring of rolling stock	• Require the relevant technological solution to be installed
Awarding of rail services, vehicles provided by PTA	• In a competitive tendering procedure - In the tendering documents, provide the necessary information for the TOC to calculate the energy saving potential from the technology in order to give all contenders the possibility to include the effect in their tender.
Awarding of rail services, vehicles provided by TOC	• In a competitive tendering procedure - In the tendering documents, provide the necessary information for the TOC to calculate the energy saving potential from the technology in order to give all contenders the possibility to include the effect in their tender. • Require the relevant technological solution to be installed

Legally “secured” text module (first example, to be further elaborated at test sites)

Example 1 – Awarding of vehicles

[Text module]

Require the vehicle to be equipped with [technology].

[Detailed description of the technology]

Example 2 – Awarding of services, vehicles provided by PTA

[Include specification of the services – service profile, scheduling etc.]

[Detailed description of the technology]

Example 3 – Awarding of services, vehicles provided by TOC

[Include specification of the services – service profile, scheduling etc.]

[text module]

The vehicle used for the services is to be equipped with [technology].

[Detailed description of the technology]

6.3.4 Compliance to legal framework

Should be in compliance with European legal framework, but is depending on availability of technology (manufacturers etc.). Important that every contender knows about the effect of energy saving potential in order to avoid giving the incumbent TOC an advantage.

It could also be difficult for the PTA to include this technology in awarding, since it requires knowledge about the technology.

Part III

6.4 Storage of energy in fixed installations (super capacitors)

During the braking phases some trains already in service and almost all of the new electric trains or locomotives are able to return energy to the overhead-line if this can receive it (e.g. when other trains are in traction phase and quite near to the braking train). On some networks the operational situation does not allow the reception and immediate re-use of energy. For this reason, the new energy storage technologies, such as super-capacitors, could be considered and collocated in fixed installation near stations where many trains a day stop. These or other trains could reuse the energy stored in their start phase or other use of this energy could be done.
Power supply optimization system for storage in fixed installation can be in substations or along the track and it operates on purely electrical basis.

6.4.1 Pros and cons

Direct use of recuperated energy by other trains is usually possible on bigger networks with dense traffic provided that braking and acceleration happens randomly. In the following cases the use of fixed installations for the storage of energy should be considered:

- DC operation (because it is not viable to transport the electric energy over a longer distance without significant losses and negative impact on the catenary);
- “Integral integrated timetable” (because with this timetable concept all trains systematically brake and accelerate more or less at the same time every half or full hour; thus re-use of energy is only possible after a few minutes);
- Advantages of onboard storage are not relevant on the particular network (e.g. saving of investment costs for the power supply system, ability to drive without overhead wire on certain stretches of the line or in case of breakdowns).

Advantages:

- The highest energetic benefit of energy storage systems can be achieved in parts of the network with a low degree of cross-linking (low probability of direct use by other trains), with slopes and high speeds (high amounts of braking energy).
- In contrast, tightly meshed parts of the network with low speeds favour a direct interchange of braking energy.

Disadvantages:

- The energy flows in the system are managed in a way that braking energy is stored only if no other train can use the energy directly. In other words there is a clear hierarchy: a) direct use by other train; b) storage.
- An important issue is the layout of the storage system. Assuming a 50 t light rail vehicle and a maximum speed of 80 km/h, the critical energy is 3,4 kWh. There is a complex trade-off between technological and economic needs. On the one hand, the storage unit should be dimensioned in such a way that it supplies enough energy and power for a train to accelerate without additional energy supply. On the other hand, storage systems have high investment costs and no unnecessary storage capacity should be installed.
- The loading of on board supercapacitors by means of fix supercapacitors leads to two main difficulties: a) the total number of supercapacitors, which is quite huge regarding the price of those components today; b) the definition of control criteria able to manage the energy exchange between two supercapacitive tanks.

INDICATORS	POTENTIALS	
Energy savings potential	**Electric Traction**	
	5-10% for DC systems	
Pollutants emissions saving potential:	**Electric Traction**	
CO_2 emission saving potential	depending on energy mix	
NO_x emission saving potential	depending on energy mix	
CO emission saving potential	depending on energy mix	
HC emission saving potential	depending on energy mix	
Particulate emission saving potential	depending on energy mix	
Economic potential (on LCC basis):		
Implementation Cost (IC)	High	
Operational Cost (OC)	Lower	
Maintenance Cost (MC)	Low	
Disposal Cost (DC)	Medium	
Implementation time:	**description**	**years**
Development time	Mature and reliable technology	<1 year
Administrative time:		
○ Financial	This could be a bottleneck, depending on the given country.	<1 year
○ Technical	Expected technological development is highly dynamic.	1 year
○ Legal	No legal process linked to the installation of the equipment for use braking energy with super-capacitors in rail infrastructure.	<1 year
○ Management	Use of energy recovering braking energy by super-capacitors in fixed installations is a choice of the management. It is dependent on the infrastructure development and on the recovering ability of already existing and future rolling stock.	<5 years
Construction time Installation time	The construction time for new rolling stock equipped with recovering storage device with super-capacitors is similar to other types of rolling stock. Additionally the infrastructure construction time is important.	< 5 years
Total time		<5 years

NB: The values in the above table have been calculated referring to a situation with one fixed installation having the capacity to recover contemporary the braking energy related to maximum 4 trains. Therefore the evaluation can be different from this one, depending on specific traffic nearthe fixed installation.

6.4.2 How to include in awarding procedure

This technology mostly concerns the relationship with the Infrastructure Manager. Necessary onboard technology can be included as a requirement for vehicles which are to be used for the services. In case of PTA providing the vehicles it is included in the awarding of rolling stock. If vehicles are provided by the TOC it is included in the awarding of services and defined in the Public Service contract that the vehicles are to be equipped with the technology. The detailed functionality of the energy recovery/regeneration/storage system must be specified in the invitation to tender.

Regardless if vehicles are provided by TOC or PTA, the contenders need to be able to calculate the energy savings potential in order to avoid giving the incumbent TOC a competitive advantage. Therefore, when awarding services through a competitive tendering procedure, the characteristics of the services should also be specified (stops, line profile etc.).

Steps for including in awarding procedure	
Procuring of rolling stock	• Require the relevant technological solution to be installed
Awarding of rail services, vehicles provided by PTA	• In a competitive tendering procedure - In the tendering documents, provide the necessary information for the TOC to calculate the energy saving potential from the technology in order to give all contenders the possibility to include the effect in their tender.
Awarding of rail services, vehicles provided by TOC	• In a competitive tendering procedure - In the tendering documents, provide the necessary information for the TOC to calculate the energy saving potential from the technology in order to give all contenders the possibility to include the effect in their tender. • Require the relevant technological solution to be installed

Legally "secured" text module (first example, to be further elaborated at test sites)

Example 1 – Awarding of vehicles

[Text module]

Require the vehicle to be equipped with [onboard technology].

[Detailed description of the technology]

Example 2 – Awarding of services, vehicles provided by PTA

[Include specification of the services – service profile, scheduling etc.]

[Detailed description of the technology]

Example 3 – Awarding of services, vehicles provided by TOC

[Include specification of the services – service profile, scheduling etc.]

[text module]

The vehicle used for the services is to be equipped with [description of technology].

[Detailed description of the technology]

Part III

6.5. Further criteria

(…)

Part III

7. Life Cycle Costs (LCC) and Cost-Benefit-Analysis (CBA)

To compare the trade-off between investment and operational as well as maintenance costs of different technologies and to find the best solution for a specific use case the selection of technologies and operational measures should consider all costs that occur during its lifecycle or at least the duration of the respective contract.

For the calculation of lifecycle costs (LCC) particularly maintenance as well as recycling or disposal costs have to be taken into account besides the investment and operational costs. This analysis concentrates on the lifecycle of the evaluated technology independent of the parties involved.

It should be noted that especially the operational costs and to a lesser degree the maintenance costs are variable and strongly dependent on the operating program and fielding conditions. Therefore the calculation should be made for specific operating scenarios corresponding with the planned conditions of future use.

Another factor of the decision-making process should be a cost-benefit analysis regarding the use of selected technologies and operational measures for its specific use case. The aim thereof is the identification of the additional costs and benefits of the analysed technologies and operational measures for the involved parties (PTA, TOC, IM).
This analysis – in contrast to a lifecycle cost analysis – focuses on the costs and benefits during the duration of the contract for a specific contractual partner. For a complete determination of the costs and benefits individual analyses for each involved partner have to be completed.
In the analysis only monetary benefits should be considered. These are mostly reduced operation and maintenance costs as well as avoided investment costs (e.g. not necessary sound protection measures for residents, avoided depot extension for additional vehicles due to lower specific maintenance demand, etc.).

For lifecycle cost analyses as well as cost benefit analyses the relevant costs are mainly:

- Investment costs for infrastructure, vehicle equipment as well as supplementary equipment
- Operational costs
- Maintenance costs
- Refit costs (where necessary)
- Recycling costs (where necessary)
- Disposal costs (where necessary)

These costs have to be matched for the specific use case or scenario. ‘Therefore the important operational characteristics (e.g. number of vehicles used, mileage per vehicle, service profile, etc.) should be collected for the respective scenario, so that common indicators (e.g. time-dependent and mileage-dependent maintenance cycle, operational costs per train-km, etc.) can be used. To consider the influences of inflation future costs also have to be discounted (inflation-adjusted).

Today most of the necessary indicators for future technologies are yet undetermined. Some estimates can be found in literature sources but the main source for the necessary data will be the suppliers as well as operators for technologies that are already in use.
Based on the available data there is currently only a general qualitative analysis possible.

The analysis of the technologies and operational measures shows that only one third of the short-term technologies and 6% of the operational measures will mean medium or high operating and/or investment costs. When it comes to long term horizon technologies the share is somewhat higher with about 46% meaning medium or high operating and/or investment costs. At the same time about 2/3 of the technologies (short term as well as long term horizon) and operational measures will give significant reduction in the vehicle running costs.

The combination of low vehicle and infrastructure fix costs with a significant reduction of vehicle running costs that gives the best results for the purpose of a cost-benefit analysis can be found in 36% of the technologies and 38% of the operational measures. Mainly these are technologies to improve traction equipment efficiency (technology cluster 5), for train formation and typology (technology cluster 1) and to optimise comfort functions (technology cluster 3) as well as operational measures regarding training programs (operational cluster 1), energetic optimisation of timetable (operational cluster 2) and the use of energy meters (operational cluster 5).

In some cases, the TOC don’t bear the real costs for the electric traction, since the energy prices for the railway network, could be more or less heavily subsided. In these cases, introducing EE/EF criteria that leads to energy savings, will have limited effects then it comes to reducing the costs. This means that it can be harder to reach the return on investments.

Part III

8. Stand-by and comfort functions

(...)

Cluster Optimisation of comfort functions: this cluster includes all technologies concerning a new management of comfort functions oriented to avoid wasting electricity. The term "comfort functions" refers to those elements that are important for on-board people (passengers and personnel) like lighting system or system regulating the inner climate. The idea, on which these technologies are based, is adapting the energy consumptions to the different demand situations and avoiding the heat dispersions through the use of insulating materials.

(...)

8.1 Control of comfort functions in parked trains

8.1.1 General description

Parked passenger trains are often heated all night. This consumes substantial amounts of energy. A possible solution is the development and implementation of an intelligent control tool for parked trains (e.g. pre-heating time of rolling stock as a function of external temperature, etc). Besides the installation of an automated controlled system, simple effective solutions include timers, manual control and instructions for maintenance and cleaning personnel.
Existing solutions mainly differ with respect to the following features:

- Centralised control device for the entire train
- Possibility to operate lighting and heating at one third or half intensity
- Special programs for anti-freezing or preheating operation.

Advantages: many railway companies apply control devices to reduce the energy demand during overnight standstill to a certain degree.
Dynamic development of Control of comfort functions in parked trains is especially oriented in the field of telematic control solutions.
Some operators are reluctant to switch off heating in the night due to the danger of freezing and damage to equipment.
Control of comfort functions in parked trains is applicable for electric - DC, electric - AC, diesel railway traction in passenger - main lines, passenger - high speed, passenger - regional lines, and passenger - suburban lines.

Success factors:

- Assessment of current operation practice for standstill in order to identify possible measures and required functionalities of an automatic control tool.
- Motivation and incentives of cleaning personnel to collaborate in saving measures;
- Advanced control systems to avoid danger of freezing etc.

Disadvantages: the on-board equipment for controlling comfort functions is highly variable between vehicles. The heterogeneity of stock impedes the development of a generalized automatic control with big scale effects.
The coaches have to be warm when the trains are cleaned. However, the time when the cleaning personnel arrives may vary too much to program the timer in a way to take this into

consideration. Due to low salaries, the motivation of cleaning personnel to collaborate in such measures may generally be low.

Benchmark: According to different sources, in countries of Central and Northern Europe energy consumption during standstill is up to 10% of the total energy demand for train operation. In Mediterranean countries, the share will be lower. It is a reasonable estimate to assume that this energy can be reduced by ~ 50% by an intelligent control system. So the saving potential is about 2 - 5 % per vehicle.
Swedish SJ has developed an automatic control tool (called PLC - Programmable Logistic Control) to tackle the problem.
Compared to calculations made by SJ in the context of their introduction of the PLC system the operator estimated a saving potential of 15.000 kWh per year and coach. Given the total consumption for coach heating of about 55.000 kWh per year and coach, the measure is expected to save between 20 and 30% of the energy consumed for heating.
The system optimises the use of electricity so that heat and light is minimized during parking hours, but automatically switched back on well before service starts again. At the end of service, coach temperature is lowered to 12° C, and raised again to service temperature one hour before service start. The system is currently tested in a pilot project involving 4 coaches.

INDICATORS	POTENTIALS	
Energy savings potential	In Mediterranean countries: 3-5% In Northern countries: 4-9%	
Pollutants emissions saving potential:	**Electric Traction**	**Diesel Traction**
CO_2 emission saving potential	depending on energy mix	In Mediterranean countries: 3-5% In Northern countries: 4-9%
NO_x emission saving potential	depending on energy mix	In Mediterranean countries: 3-5% In Northern countries: 4-9%
CO emission saving potential	depending on energy mix	In Mediterranean countries: 3-5% In Northern countries: 4-9%
HC emission saving potential	depending on energy mix	In Mediterranean countries: 3-5% In Northern countries: 4-9%
Particulate emission saving potential	depending on energy mix	In Mediterranean countries: 3-5% In Northern countries: 4-9%
Economic potential (on LCC basis):		
Implementation Cost (IC)	Low	
Operational Cost (OC)	Lower	
Maintenance Cost (MC)	Low	
Disposal Cost (DC)	Low	
Implementation time:	**Description**	**years**
Development time	Status of development of Control of comfort functions in parked trains: in use	<1 year
Administrative time:		
○ Financial	This could be a bottleneck, depending on the given country.	<1 year
○ Technical	The needed know-how exists and is available. The installation of an automatic control tool is rather cheap as long as rolling stock offers a convenient interface for such a system, e.g. a central control for the comfort functions. Especially in the field of telematic control solutions, the technological development potential is still high, but it is easier to apply them on new rolling stock	1 year
○ Legal	No legal process linked to the installation of on-board equipment for controlling comfort functions.	<1year
○ Management	A successful development and implementation of an automatic system for the control of comfort functions in parked trains has to be preceded by a thorough assessment of types of passenger coaches and operational practice in the treatment of parked trains. Energy meters equipment could be a powerful tool to improve the monitoring and communication of energy saving measures if they are in function or active to measure energy consumption during standstill.	<1 year
Construction time Installation time	Short to midterm (1 to 5 years), half of the time spent on construction and half for planning within the company.	<5 years
Total time		1-5 years

8.1.2 How to include in awarding procedure

Concerns only awarding of services (except for necessary in-vehicle technology). Criteria should be specified as a requirement included in the contract specification of maintenance procedures. Requirement should declare that the control system is to be used during a specified period (manually or automatically). The TOC is then to adjust its organisational procedures (i.e. cleaning schedules) according to this.

If maintenance facilities are owned by the TOC, the contract also needs to specify that acontrol system should be installed. It can also be included as a non-mandatory criterion used for evaluation of the tenders. If so, the TOC could in the tender specify the strategy how to reduce energy use for the parked trains. Necessary in-vehicle technologies must also be required regardless if new or existing rolling stock will be used.

Steps for including in awarding procedure	
Procuring of rolling stock	• Require necessary in-vehicle technologies
Awarding of rail services, vehicles provided by PTA	• Require control system to be used according to specification • Require organisational measures in the maintenance specification *And/Or:* • Ask for specification of how to reduce energy use for parked trains ○ Calculate the weight to be used (based on energy saving potential in relation to total estimated cost for contract.
Awarding of rail services, vehicles provided by TOC	• Require necessary in-vehicle technologies • Follow the steps above

Legally "secure" text module (first example, to be further elaborated at test sites)

Example 1 – Awarding of vehicles, Awarding of services, vehicles provided by TOC

[Text module]

Require the vehicle to be equipped with [in-vehicle technology].

[Detailed description of the technology]

Example 2 – Awarding of services, vehicles provided by PTA

[Describe the control system implemented]

[Text module]

The control system is to be used [specification of time schedule]. The TOC is responsible for adjusting the necessary measures regarding organisation of the maintenance procedures according to this.

[Describe the method for monitoring]

Example 3 – Awarding of services, weight criteria used for evaluation of tenders

[text module]

In the offer the TOC is to present its strategy for reducing energy consumption for parked trains.

[describe how to evaluate, grading, weighting]

[describe how to monitor and penalties etc.]

8.1.3 Compliance to legal framework

There should not be any problems with compliance to European legal framework but is depending on availability of technology (manufacturers etc.) Main problems should concern issues with trade unions regarding maintenance staff.

Part III

8.2 Further criteria

(…)

Part III

9. Energy-efficient driving and driver training

Cluster Eco-driving: in this cluster there are some measures that refer to energy efficient driving by studied driving strategies and eventually by driving advice systems. These solutions implicate a planned analysis of the characteristics of each line (altimetric and planimetric features, speed limits, distance between stops, etc) and of the recovery times in the timetable, the study of existing saving energy margins and then the definition of the most opportune driving strategies. Quite obviously, after this technical analysis, it is necessary to acquaint the drivers with the planned changes, to train them and often to stimulate them to do better.

9.1 Energy efficient driving by low-tech measures

9.1.1 General description

In view of the barriers impeding a fast diffusion of advanced driving advice systems, non-technological short-term efforts to promote energy efficient driving are especially promising. Many measures including training programmes for drivers can be implemented at good cost-benefit ratio and meet virtually no barriers. A considerable part of the reduction potential offered by energy efficient driving might be exploited by non-technological or low-tech measures (databases, systems based on GSM-R, laptop technology, etc).
The following driving styles for energy efficient driving can be applied:

- Coasting
- Reducing maximum speed
- Using valleys and hills

Advantages

(...)

Disadvantages
To a certain extent it depends on the vehicle design which driving style is the most effective one. This is especially true with the different types of power transmission with diesel traction.

INDICATORS	POTENTIALS		
Energy savings potential	**Electric Traction**	**Diesel Traction**	
	5-10%	5-10%	
Pollutants emissions saving potential:	**Electric Traction**	**Diesel Traction**	
CO_2 emission saving potential	depending on energy mix	5-10%	
NO_x emission saving potential	depending on energy mix	5-10%	
CO emission saving potential	depending on energy mix	5-10%	
HC emission saving potential	depending on energy mix	5-10%	
Particulate emission saving potential	depending on energy mix	5-10%	
Economic potential (on LCC basis):			
Implementation Cost (IC)	Low		
Operational Cost (OC)	Lower		
Maintenance Cost (MC)	Low		
Disposal Cost (DC)	Low		
Implementation time:	**Description**		**years**
Development time	The needed sources exist for the implementation of the programme. Thus the time need for this is quasi zero.		<1 year
Administrative time:			
○ Financial	This could be a bottleneck, depending on the given country		<1 year
○ Technical	The needed know-how exists and is available		<1year
○ Legal	No legal process linked to the adoption of such measures. Working rules to be considered		<1 year
○ Management	This is the main bottleneck		<1 year
Construction time Installation time	Ideally less than 1 year, half of the time spent on construction (i.e. planning within the company), the remaining half on installation. (i.e. carrying out the training itself).		< 1year
Total time			< 1 year

9.1.2 How to include in awarding procedure

This criterion is only relevant when awarding of services although energy meters should be required when procuring vehicles. The most straightforward way should be to require the TOC that a certain amount of their drivers need to be educated in energy efficient driving. It can also be used for evaluation of tender. The contenders should present (mandatory or non-mandatory) their proposed strategy for educate their drivers in energy-efficient driving. Further on it can also be included as an incentive regarding reduction in energy use (see chapter concerning direct indicator). Even not reducing energy consumption by itself, it could also be required that energy meters are installed in the vehicles. Through this the driver can control the energy consumption according to his driving style.

Steps for including in awarding procedure	
Independent of awarding procedures	• Describe the network • If existing vehicle to be used and electric traction, energy meters should be required to be installed
Procuring of rolling stock	• Require energy meter to be installed if electric traction • Require real time fuel consumption monitoring devices if diesel traction is used *[to be checked whether available yet]*
Awarding of rail services, vehicles provided by PTA	• Require drivers to be educated in EE driving *Or* • Weight criterion for evaluation of tender where TOCs are to describe the training program/strategy for EE driving (only relevant in a competitive tendering procedure) ○ Calculate the weight to be used (based on energy costs in relation to total operational costs)
Awarding of rail services, vehicles provided by TOC	• Require energy meters to be installed • Follow steps above

Legally "secure" text module (first example, to be further elaborated at test sites)

Example 1 – Requirement

[describe the network]

[describe the requirement]

The TOC is to educate the drivers in energy efficient driving according to [specification of training program]. For a specific year, at least [%] of the drivers must have participated in training program within [number of years] years before the specific year.

[describe the method for monitoring]

Number of drivers participating in training program, annual reporting by TOC

Example 2 – Evaluation

[describe the criteria]

> *In the bid, the TOC is to present its strategy for reducing energy consumption through energy efficient driving. The strategy should include description of training program, frequency of training, number of drivers participating etc.*

[describe how to evaluate, grading, weighting]

[describe how to monitor and penalties etc.]

9.1.3 Compliance to legal framework

In general operational measures are legally secure to include in awarding. In order to be in compliance with the non-discriminative principle within a competitive tender procedure, the tendering document needs to include a description of the characteristics of the lines and services. This is important in order for all contenders to take the potential of energy efficient driving into consideration. There can also be legal issues of technological art, for example safety issues at the drivers desk.

Part III

10. Further operational measures

(...)

Part III

11. The use of renewable energy or “alternative” fuels

(...)

Glossary

Auxiliaries
Equipment needed to operate the traction equipment, but not producing tractive or dynamic braking efforts themselves (e.g. cooling fans, oil and water pumps, and compressor). In the context of this standard, heating and / or air conditioning of the leading driver's cab is included in the auxiliaries (definition by Railenergy).

awarding, awarding procedure

baseline

cadenced timetable

cluster
A cluster is a group of → technologies or operational methods which are developed or used with the same or similar objective in terms of reduction of energy consumption. The definition of clusters is a heuristic method to analyse objectives and potentials of different approaches. The technologies and operational methods which are grouped in a specific cluster may be competing or co-acting with each other. A cluster may consist of a lot of elements (technologies / methods) while other clusters may consist only of one element.
One example for a cluster is the recuperation of "braking energy" which might be done with different methods, especially when it comes to diesel operation. Another example for a cluster is "Eco-driving / driver training" to which several elements belong which partially co-act.

Comfort systems
All equipment consuming energy, but belonging neither to the traction equipment nor to its auxiliaries, mainly in passenger cars: heating, air conditioning, toilets, information and entertainment systems, laptop supplies etc. (definition by Railenergy)

compensation level

competitive tendering

contracting out

direct awarding, direct contracting (?)

direct indicator(s)
In the context of ECORailS, a direct indicator shows directly the energy consumption of a traction unit in relation to a unit which refers to transport or operational performance. The unit of the enumerator is “kWh” (kilowatt hours) while the denominator is given as (e.g.)
“pkm” (passenger kilometer) or
seat km or
train km or
gross tonne kilometer (gross tkm).

In order to get meaningful results when comparing the energy consumption of e.g. different types of trains, it is essential to make sure that the side conditions are harmonised to a sufficient extent. Among others the following side conditions may be considered: timetable, gradients, ambient conditions, curves, occupancy, comfort functions and passenger comfort definitions. Details are given in part III, chapters 1 and 4 of the Guidelines.

Generally speaking, the use of a direct indicator is the most elegant way to integrate the energy efficiency in procurement procedures for vehicles and in awarding procedures for Public Service Contracts in passenger rail services. But there are situations and considerations when this is not possible, not meaningful or not sufficient. Therefore we propose to also use → indirect indicators or requirements for → solutions, → technologies or → clusters.

EE/EF criteria

Electric power supply
Generation and distribution of electric energy to the train: power stations, high voltage transmission lines, substations and their switchgear, catenary lines (definition by Railenergy).

gross tonne kilometer (gross tkm)

hybrid (train etc.)

indirect indicator
In the context of ECORailS, an indirect indicator describes a parameter which has a major or substantial influence on the energy consumption of a train but does not describe the energy consumption itself. A typical example for such an indirect indicator is “weight per seat” which can be used for the procurement or description of passenger carriages for loco-hauled trains.

Infrastructure
Fixed installations of the railway: tracks, power supply, signalling, communication etc. (definition by Railenergy)

Integral regular timetable (ITF)

loco-hauled train

multiple unit

operational measure

operational performance

procurement, procuring

Public Service Contract (PSC)

quote request

rail services

regular timetable

Rolling stock
all sorts of railway vehicles, with or without propulsion system, including vehicles for passenger or freight transportation (definition by Railenergy).

Single-train simulation
Simulation of the run of one train over a part of infrastructure, without inclusion of effects of other trains (definition by Railenergy).

solution
Suppliers may develop different solutions for the application of the same technology. One example is that more than one supplier offers super-capacitors for the on-board storage of energy. Asking for a specific solution can be very clause to asking for a specific product and thus cause legal problems for a PTA issuing a tender.

specific indicator for the assessment of a specific technology or a specific solution
Different → technologies or → solutions which are implemented for the same purposes may be compared with specific indicators. These indicators must be defined individually for each cluster or technology. If you want to compare different technologies of recuperative braking you may use e.g. the recuperation rate (recuperated energy compared to the overall traction energy). Of course, operational, ambient and infrastructural conditions should be harmonised for this purpose.

standard service profile (SSP)

technology
The same purpose may be pursued with different, often competing technological approaches. For instance recuperative braking may become a big issue for diesel operation in the short- or mid-term perspective. Actually different (competing) types of technology are being tested or developed such as electric braking with super-capacitors for the storage of energy, or hydraulic braking using compressed fluids for the storage of energy, or electrical braking with fly-wheels for the storage of energy. Different companies may develop different specific → solutions for the same technology.

PTA's or TOC's may require certain technologies (or → clusters) in their awarding procedures if direct or indicators do not seem to be sufficient. Additionally the analysis of (or knowledge about) available technologies is essential for PTA's when they want to know which energy savings can be achieved, at what costs this might be possible and at what levels of reliability. With respect to certain technologies even more dimensions should be analysed.

To require a technology or one technology out of a group (→ cluster) in a tender is in most cases not likely to cause problems with European legislation for competitive tendering, but this should be checked before issuing the tender (see part II and part III, chapters 6 sqq. of the Guidelines.

tender, tendering

tonne
metric tonne (abbreviation: "t"; 1 t = 1,000 kg), to be distinguished from the british "ton" ("long ton"; abbreviated as "ton") which has 1,016.0469088 kg

Total railway system simulation
Simulation of several trains over one or several parts of infrastructure (railway network), including effects of train performance, power supply characteristics, operational constraints (time table, conflicts between trains) (definition by Railenergy)

Traction equipment
Equipment directly needed to produce tractive or dynamic braking effort (e.g. transformer, converters, motors, gearboxes) (definition by railenergy)

traction unit
One or several railway vehicles with a propulsion system (definition by Railenergy)

Train
Consist of several vehicles, including at least one traction unit, all coupled and running together (definition by Railenergy).

transport performance

Wagon consist

Consist of vehicles without any traction unit (definition by Railenergy; as “wagon” usually refers to freight vehicles, ECORailS should perhaps use “carriage consist”; please comment!)

6. Abbreviations

dB, dB (A)

DMU

eaci

EE

EF

EMU

ENV

IEE

IM

kWh

MU

pkm

PSC

PTA

SSP

TOC

UIC

UITP

UNIFE

Bibliography